

Fishery Data Series No. 08-31

Sonar Enumeration of Pacific Salmon Escapement into the Nushagak River, 2004

by

Chuck Brazil

June 2008

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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Weights and measures (metric)		General		Measures (fisheries)	
centimeter	cm	Alaska Administrative Code	AAC	fork length	FL
deciliter	dL	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	mideye-to-fork	MEF
gram	g			mideye-to-tail-fork	METF
hectare	ha			standard length	SL
kilogram	kg			total length	TL
kilometer	km	all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.		
liter	L				
meter	m	at	@		
milliliter	mL	compass directions:			
millimeter	mm	east	E		
		north	N		
		south	S		
		west	W		
		copyright	©		
		corporate suffixes:			
		Company	Co.	alternate hypothesis	H _A
		Corporation	Corp.	base of natural logarithm	e
		Incorporated	Inc.	catch per unit effort	CPUE
		Limited	Ltd.	coefficient of variation	CV
		District of Columbia	D.C.	common test statistics	(F, t, χ ² , etc.)
		et alii (and others)	et al.	confidence interval	CI
		et cetera (and so forth)	etc.	correlation coefficient (multiple)	R
		exempli gratia		correlation coefficient (simple)	r
		(for example)	e.g.	covariance	cov
		Federal Information Code	FIC	degree (angular)	°
		id est (that is)	i.e.	degrees of freedom	df
		latitude or longitude	lat. or long.	expected value	E
		monetary symbols		greater than	>
		(U.S.)	\$, ¢	greater than or equal to	≥
		months (tables and figures): first three letters	Jan,...,Dec	harvest per unit effort	HPUE
		registered trademark	®	less than	<
		trademark	™	less than or equal to	≤
		United States		logarithm (natural)	ln
		(adjective)	U.S.	logarithm (base 10)	log
		United States of America (noun)	USA	logarithm (specify base)	log _b , etc.
		U.S.C.	United States Code	minute (angular)	'
		U.S. state	use two-letter abbreviations (e.g., AK, WA)	not significant	NS
				null hypothesis	H ₀
				percent	%
				probability	P
				probability of a type I error (rejection of the null hypothesis when true)	α
				probability of a type II error (acceptance of the null hypothesis when false)	β
				second (angular)	"
				standard deviation	SD
				standard error	SE
				variance	
				population	Var
				sample	var

FISHERY DATA SERIES NO. 08-31

**SONAR ENUMERATION OF PACIFIC SALMON ESCAPEMENT INTO
THE NUSHAGAK RIVER, 2004**

by
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ABSTRACT

Hydroacoustic techniques were used to develop escapement estimates of sockeye *Oncorhynchus nerka*, Chinook *O. tshawytscha*, chum *O. keta*, coho salmon *O. kisutch*, and pink *O. gorbuscha* salmon for the Nushagak River in Bristol Bay, Alaska from 8 June through 16 August, 2004. Estimates of species, age, sex, and size composition were derived from samples obtained with drift gillnets at the sonar site. Final escapement estimates through August 16 were 491,730 sockeye, 116,400 Chinook, 283,811 chum, 152,613 coho, and 556,066 pink salmon. Escapement run timing of sockeye salmon was 4 days earlier and Chinook salmon was 3 days earlier than the 1990–2003 average. The major age classes estimated for sockeye salmon were age-1.3 (62.4%), age-1.2 (17.9%), and age-1.4 (11.6%). The major age classes estimated for Chinook salmon were age-1.3 (42.5%), age-1.4 (32.4%), and age-1.2 (24.2%). Comparative studies on the Nushagak River were conducted using a standard range (SR), left (south) bank facing downriver in 2003 and 2004, and long range (LR), right (north) bank facing downriver in 2004, dual frequency identification sonar (DIDSON) to determine whether the DIDSON would be a viable replacement of Bendix sonars currently used to estimate salmon passage. We recommend that the short range DIDSON replace the Bendix system for estimating salmon escapement on the left (south) bank of the Nushagak River in 2005. We further recommend that testing continue with the long range (LR) DIDSON on the right bank in 2005. In addition, DIDSON training should be conducted for all sonar personnel.

Key words: Pacific salmon, sonar, Nushagak River, Bristol Bay, escapement, estimation, fisheries management, *Oncorhynchus*.

INTRODUCTION

The purpose of this study was to estimate the escapement of the following 5 species of Pacific salmon *Oncorhynchus spp.* for the Nushagak River in Bristol Bay, Alaska: sockeye *O. nerka*, Chinook *O. tshawytscha*, chum *O. keta*, coho *O. kisutch*, and pink *O. gorbuscha* salmon. This project provided escapement estimates that are used to assess daily run strength and provide escapement goal information that is critical to the management of local salmon fisheries.

In 1979, the Alaska Department of Fish and Game (ADF&G) examined the feasibility of using hydroacoustic (sonar) equipment on the Nushagak River and began developing techniques to estimate adult salmon abundance (McBride 1981). During subsequent years, the Nushagak River sonar project has evolved to provide daily escapement information important to the management of commercial salmon fishing in the Nushagak District.

Estimating the numbers of salmon migrating into Nushagak River involves (1) estimating the number of hydroacoustic targets passing through the sonar beams, (2) estimating the species composition of those targets, and (3) combining estimates of hydroacoustic targets and species composition to estimate numbers of passing salmon by species (Miller et al. 1994a).

All hydroacoustic estimates in 2004 were made using Bendix¹ sonar equipment; however, the sonar project is currently in a state of transition. Since the recent retirement of Al Menin, the engineer who designed, built, and maintained the Bendix sonar, the Bendix Corporation no longer manufactures nor supports these systems and there are limited replacements available. In addition, the Bendix sonar equipment has several limitations for estimating salmon escapement such as limited range, and inability to determine direction of travel (upstream or downstream). Further, signal processing occurs in short term memory with no storage mechanism for the raw signal, and the system was designed to produce only a final count. Therefore, counts cannot be

¹ Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

reviewed or reproduced later. These circumstances have led the ADF&G to conduct comparative studies to replace Bendix sonar systems on the Nushagak River.

In 2002, the ADF&G tested the feasibility of estimating migrating adult salmon in the Wood and Copper rivers, using a standard-range (SR) dual-frequency identification sonar (DIDSON) to determine whether the DIDSON is a viable replacement for the existing and older Bendix counters (Maxwell and Gove 2002). DIDSON is a high-frequency, multi-beam sonar with a unique acoustic lens system designed to focus the beam to create high-resolution images. Originally developed by the University of Washington, Applied Physics Laboratory, to allow divers to identify mines in turbid waters, the DIDSON creates video-like images (Belcher et al. 2001; Belcher et al. 2002).

The DIDSON's small pulse widths, high frequency, and extremely small multiple beams simplify visually identifiable fish targets and minimize problems that can occur when more than 1 fish is in the beam. The higher than standard frequency waves reflect off the fish surface rather than only the swim bladder, creating a more accurate image of the fish compared to Bendix sonar that produces a series of echoes.

During the 2003 and 2004 field seasons, the standard DIDSON was deployed on the left (south) bank (facing downriver) of the Nushagak River in a comparative study alongside the Bendix (Maxwell et. al. *In prep*). The SR DIDSON was operated at 2 frequencies, 1.80 MHz with range settings to 10 meters and 1.10 MHz with range settings to 36 meters, providing approximately the same coverage as the Bendix sonar counter. Comparisons between the DIDSON and Bendix on the left bank are going to be presented for both 2003 and 2004.

In 2004, a newly developed long-range (LR) DIDSON was operated upstream of the Bendix counter on the right (north) bank (facing downriver). The LR DIDSON was operated at 2 frequencies, 1.20 MHz with range settings to 20 meters and 0.70 MHz with range settings to 60 meters, providing greater river coverage than the current Bendix counter system. Side-by-side comparison studies of the LR DIDSON and Bendix will continue during the 2005 season (Maxwell et. al. *In prep*). Additional comparisons of hydroacoustic estimates between the Bendix counter and DIDSON will be made in future years.

Equally important as estimating the numbers of fish migrating upstream is an accurate estimate of the species composition. An estimate of fish species passage is made by drifting a suite of various sized gillnets in the ensonified area of the river and estimating catch-per-unit-effort for each species. Numerous changes have been made in the methods used to sample and estimate species composition since project inception. Brannian et al. (1995) evaluated escapement sampling and the associated species apportionment methods used on Nushagak River during 1991 and compared them with methods used on the Lower Yukon River. Based on their review, new methods of estimating Nushagak River salmon passage by species were incorporated in 1992 (Miller et al. 1994a). The method used from 1992 through 2001 created a situation where preliminary species composition estimates were made over several days until 100 salmon were caught. After 100 salmon were caught, the preliminary species composition estimates were retroactively updated during the season, thus numerous inseason changes were made to the escapement estimates for all species. It was determined in 2002 that using a sample size of 5 fish to estimate species composition during a report period had minimal effects on the daily estimates and was less biased and more accurate (McKinley 2003) (Appendix D1). This method has the advantage of providing almost daily estimates of escapement that do not change retroactively.

OBJECTIVES

The project objectives in 2004 were to:

1. Estimate the number of adult sockeye, Chinook, chum, pink, and coho salmon in the Nushagak River from early June through late August such that the escapement estimates were within +/- 10% of the true value 90% of the time;
2. Estimate the proportion of each of the major sockeye salmon age classes (1.2, 2.2, 1.3, 2.3, 1.4) in the Nushagak River to within 5% of the true proportion 90% of the time;
3. Estimate the sex compositions of the escapements of sockeye, Chinook, chum, and coho salmon in the Nushagak River; and
4. Estimate the mean length by age of sockeye, Chinook, chum, and coho salmon in the Nushagak River escapement.

In addition to these objectives, there were several tasks accomplished in 2004. These included:

- a) Compare escapement estimates from DIDSON and Bendix on the left (south) bank;
- b) Collect weather observations (temperature, precipitation, water clarity, etc) on a daily basis at the sonar site; and
- c) Collect DNA tissue samples from sockeye salmon for estimating the stock-specific composition of the escapement.

Estimating salmon escapement into the Nushagak River with sonar involved combining the estimate of the number of salmon-sized hydroacoustic targets passing through the sonar beam(s) with the species composition estimate determined through test-fishing with drift gillnets.

METHODS

STUDY SITE

The Nushagak River is located in Southwestern Alaska and flows approximately 390 km from its headwaters to Bristol Bay (Figure 1). The Nushagak drainage has 2 main tributaries: the Nuyakuk River, draining Tikchik Lakes, which enter from the west, and the Mulchatna River, which flows into the Nushagak from the east. These rivers support large runs of 5 species of Pacific salmon (Table 1) as well as several resident species that are harvested in commercial, sport and subsistence fisheries.

The project site was located on the lower Nushagak River, approximately 40 km upstream from the terminus of the Nushagak commercial fishing district and 4 km downstream from the village of Portage Creek (Figure 1). Almost the entire project site is contained to one 300 m wide channel of the river, with the exception of 1 very small slough behind the camp. The site is influenced by tides that cause a reduction of current during high tide; however there is rarely a reversal of flow and there appears to be few fish milling in the area. Stock identification studies based on scale pattern analysis (Robertson 1984) indicated that the majority (93%) of sockeye salmon migrating past Portage Creek were destined for the Nushagak, Mulchatna, or Nuyakuk rivers. Therefore, very few fish migrating through the project site are assumed to be strays from other rivers that might back out of the river or migrate back downstream at a later date.

PROJECT DATE

Project operation dates have varied over the years. From 1982 to 2004, with the exception of 1992 and 2003, operation dates extended from early June to at least 16 August each season to include the majority of the run for all salmon species. In 1992, the project terminated on 22 July due to budget shortfalls. Similarly, in 2003 with declining budgets the project terminated on 20 July, a date that historically includes about 96% of the cumulative sockeye salmon passage. In 2004, the Bristol Bay Science & Research Institute (BBSRI) provided funds that allowed the project to extend to 18 August to estimate the coho salmon escapement.

HYDROACOUSTIC ESTIMATES

Bendix

The sonar equipment used for the estimation of the Nushagak salmon run from 1979 to 2004 (King and Tarbox 1989) consisted of an echo counter and transducer manufactured by Bendix Corporation, an oscilloscope, and a power supply (12 volt battery with solar panel). Both an inshore and offshore Bendix system was implemented on each bank of the river for a total of 4 systems. The counting range of inshore echo counters was divided into 12 sectors, and the counting range of offshore echo counters was divided into 16 sectors. All Bendix echo counters were operated at 515 kHz with a narrow pulse width of 100- μ s and alternated between a 2° (offshore) and 4° (inshore) beam sizes. Pulse repetition rate, counting range, and sensitivity were adjustable.

Placement of the transducers and counting ranges were determined by the river bottom contour. Slope changes in the river bottom contour required the deployment of 2 transducers (inshore and offshore) on each riverbank. Offshore transducers, located where the slope of the river bottom changed, were aimed perpendicular to the water flow and towards the middle of the river. Inshore transducers were deployed within 10 m of shore in water of sufficient depth for fish passage and counted out to the offshore transducer.

Transducers were mounted on metal tripods and aimed, with the aid of an oscilloscope, to ensonify the lower portion of the water column. The majority of the upstream migrating salmon are assumed to travel close to the river bottom due to reduction of water resistance. In a previous experiment, it was suggested that over 88% of the fish occupied the lower two-fifths of the water column at the Nushagak River sonar site (Minard 1985). Offshore transducers were aimed with remote-controlled pan and tilt rotators, whereas inshore transducers were aimed manually by adjusting the angle of the transducer mounts on the tripods. Once proper aim was established, a picket weir was constructed of pipe, aluminum angle, and plastic fencing from the shore to just beyond the inshore transducer on both riverbanks to prevent fish from passing behind the transducers or within approximately 1 m of the transducer face, an area in which the system may not detect fish.

Pulse repetition rate was adjusted on each counter to maintain counting precision at \pm 90%, using calibration procedures described by Minard and Frederickson (1983). Counters were calibrated by comparing the output counts recorded by the sonar counter to those recorded by a trained technician observing an oscilloscope pattern of the signal received by that counter. Counts from the oscilloscope were hand tallied for either a 10-min period or 100 counts, whichever came first. At the end of the counting interval, the oscilloscope count was divided by the Bendix count to yield a percent agreement between the two. If the percent agreement was less than 90% or

greater than 110%, the pulse repetition rate was adjusted until an acceptable percent agreement was achieved. Counters were calibrated throughout the day between 0600 and 2400 hours. The frequency of calibrations was somewhat dependent upon fish passage rates and the variability of fish swimming speeds; at least 1 calibration per hour was conducted during periods of peak fish passage. Sonar count data were summarized by sector, counter location (inshore, offshore, left or right bank), hour, and day to evaluate spatial and temporal distributions of sonar counts.

DIDSON: Left (South) Bank

During the 2003 and 2004 field season, the standard DIDSON was deployed on the left (south) bank (facing downriver) of the Nushagak River alongside the Bendix and comparisons between the 2 sonars are going to be presented for both 2003 and 2004.

The left bank SR DIDSON was deployed with a Hydroacoustics Technology Inc. automated, single-axis rotator, and a BioSonics attitude sensor that provided heading, pitch, and roll data in 1-s intervals. The DIDSON was affixed to the rotator, mounted on aluminum brackets. A Dell laptop computer controlled the DIDSON via a wireless setup located on the right bank. Left bank DIDSON counts were divided into two 10-min hourly counts and in 2 strata: (1) inshore, 1–10 m, and (2) offshore, 10–30 m. These ranges were chosen so that they would be similar to the Bendix counting ranges.

An attitude sensor was attached to the DIDSON and leveled manually with a bubble level. The DIDSON was deployed just upstream of the inshore Bendix in water deep enough to cover the entire DIDSON at low water, located approximately 0.19 m (7.5 inches) from the river bottom. Proper orientation for the best image was obtained by adjusting the heading, pitch and roll sensors. Target testing was conducted with a tungsten steel ball passed through the sonar beam vertically and horizontally.

DIDSON: Counting Fish on DIDSON (Playback of files)

Playback of 10-min count files for near-shore and off shore strata was completed hourly throughout the day: (1) Previously recorded files were moved into that day's file folder; (2) The DIDSON program that was set to record was minimized and a second copy of the DIDSON program opened; (3) Demo mode was then enabled by selecting OK in the pop up message box; (4) Timer recording was unchecked using the DIDSON tool bar by going to the image drop down box and selecting capture; (5) The frame rate was set in the sonar control box to a reasonable frame rate to count passing fish. The intensity was set in the sonar control box to 90 and threshold to 10 for inshore counts, while the intensity was set to 40 and threshold to 4 for offshore counts. Background subtraction was selected to remove interference; (6) Play was then selected on the tool bar, blue forward arrow, to start the file playback; (7) Fish were counted passing upstream and downstream with separate handheld tally counters; (8) Upstream and downstream counts were recorded manually on the data form, "DIDSON Sonar Counts", for each bank and strata then entered into an excel spreadsheet ("Sonar All.xls"); (9) The next file was retrieved by selecting the black arrow in the DIDSON tool bar and the blue play arrow; (10) When counts were complete the DIDSON counting program was closed; (11) The pivot table in the "Sonar All.xls" files was refreshed after entering data and the file saved; and (12) Completed 10-min count files were saved on an external hard drive in that day's folder and later copied to a DVD backup.

Missing 10-min DIDSON counts were not interpolated for comparison purposes with Bendix counts. Entering the 10-min counts provided an accurate cross check of each day's hourly counts by stratum.

SPECIES COMPOSITION SAMPLING

Daily sonar counts were apportioned among salmon species based on species proportions in samples collected with 18.3-m (10 fathom) drift gillnets with mesh sizes of 20.6 cm (8.125 in), 15.2 cm (6.0 in), 13.0 cm (5.125 in), and 11.4 cm (4.5). All gillnets were composed of mono twist filament webbing dyed either Momoi shade #3 or Tairyo shade #T-14 (both were translucent light green). Twine size was dependent upon mesh size with 13.0-cm and 15.2-cm mesh gillnets having a Momoi #63 twine size, and 20.6-cm mesh gillnets having a Momoi #93 or equivalent twine size. Gillnet depth was 60 meshes deep (approximately 5 m) for the 11.4 cm mesh gillnets, 45 meshes deep (approximately 4–5 m) for the 13.0-cm mesh gillnets, 45 meshes deep for the 15.2-cm mesh gillnets, and 29 meshes deep (approximately 5–6 m) for the 20.6-cm mesh gillnets. Each gillnet was assumed deep enough to fully sample the entire water column.

Sampling with gillnets occurred just downstream of the transducers so that catches would represent the relative abundance of fish passing through the sonar beams. Because of the possibility that species composition was different between the inshore and offshore counting ranges, separate samples were taken for each stratum. Inshore drifts with gillnets were started with one end on the bank, while offshore drifts were started with the inshore end of the net approximately the same distance from shore as the offshore transducer. For estimating species composition, 4 area strata were defined (Left Inshore, Left Offshore, Right Inshore, Right Offshore).

The 13.0 cm and 15.2 cm mesh gillnets were fished for the entire season (8 June–16 August), while the 20.6 cm mesh gillnet was fished during the period of Chinook salmon passage (8 June–23 July), and the 11.4 cm mesh gillnet during the period of pink salmon passage (24 July–16 August). Each gillnet mesh was fished for a minimum of 2 drifts inshore and 2 drifts offshore on each bank during each set of drifts. During the period of peak sockeye salmon passage (17 June–15 July), drift sessions were conducted 3 times daily: morning (0800–1100 hours), midday (1300–1600 hours), and evening (1800–2100 hours). Prior to 17 June and after 15 July, drift sessions were conducted twice daily: mid-morning (0800–1100 hours) and early evening (1600–1900 hours). Drifts were not conducted at night because poor light conditions would make it impossible to maintain a drift within assigned strata and for safety. The maximum number of drifts conducted for each mesh size along each bank's inshore and offshore strata was 6 per day.

The data recorded for each gillnet drift included: (1) date, (2) drift session number (1= morning, 2= afternoon, 3=evening), (3) boat operator, (4) drift number sequentially ordered through the season, (5) mesh size, (6) river bank (right or left), (7) location (inshore or offshore), (8) fishing time, (9) number and species of catch, (10) length of each fish caught from mideye to tail fork to the nearest 5 millimeter (mm), (11) sex as determined from external characteristics, (12) 1 scale was retained from each sockeye and chum salmon, (13) 3 scales from each Chinook and coho salmon, and (14) time net start out and time net start in (to the nearest second).

SPECIES COMPOSITION ESTIMATES

Daily estimates of escapement by species were based on sonar count data and catch samples. Daily sonar counts were apportioned to species by bank and counting range. Catch per fathom-

hour (CPUE) was estimated for all species of salmon from the 4 ensonified escapement sampling stations (#1–4) and was used to apportion sonar counts.

Escapement estimates are affected to some degree by the combination of mesh sizes used in apportioning sonar counts. Miller et al. (1994b) and Miller (1995) found no discernable size selectivity for sockeye, Chinook, or chum salmon with 13.0- and 15.2-cm mesh gillnets. The 20.6-cm mesh gillnet, however, tended to select for large sockeye and chum salmon. Therefore, only 13.0- and 15.2-cm mesh data were used to apportion sockeye and chum salmon, while data from all 3 mesh sizes (13.0-, 15.2-, and 20.6-cm) were used to apportion Chinook salmon (Brannian et al. 1995).

To estimate fishing effort, fishing time (FT) was measured to the nearest second and recorded in decimal minutes and calculated for each drift by,

$$FT = RI - FD \quad (1)$$

where FD was the point in time when the net was fully deployed and RI was the point in time when net retrieval was initiated.

The number of fathom-hours (FH) was then calculated by,

$$FH = \frac{fFT}{60} \quad (2)$$

where f was net length in fathoms (generally 10).

The CPUE for each salmon species was based on a specific subset of gillnet mesh sizes, specified later in this report. The CPUE for each species (i) on day j in stratum k was calculated by summing the number caught (C_{ijkmn}) across mesh size (m) and drift (n):

$$CPUE_{ijk} = \frac{\sum_{m=1}^3 \sum_{n=1}^6 u_{im} C_{ijkmn}}{\sum_{m=1}^3 \sum_{n=1}^6 u_{im} FH_{jkmn}} \quad (3)$$

where u_{im} equals 1 if species i from mesh m is used to estimate species composition, and u_{im} equals 0 otherwise.

The CPUE will be cumulated across days to create a time (t) and area stratified estimate of species composition. The duration of a time stratum (report period) varied by range and bank and is specified as an input file. The minimum sample size for each time-area stratum was 5 salmon. The rational for the 5 fish minimum sample size is outlined in Appendix D1. If less than 5 salmon are captured during a day in an area stratum, catches from any gear type, from previous days will be accumulated until at least 5 salmon are obtained from all gear types, to define a reporting period. There are j^k days in period t and stratum k . The CPUE will be used to estimate the proportion of species i in report period t and area stratum k :

$$CPUE_{itk} = \sum_{j=1}^{j^k} CPUE_{ijk} \quad (4)$$

Estimates of the proportion (S_{itk}) of species i for report period t^k and area stratum k were estimated by:

$$\hat{S}_{itk} = \frac{CPUE_{itk}}{\sum_{i=1}^5 CPUE_{itk}} \quad (5)$$

The variance of \hat{S}_{itk} was estimated assuming that gillnet sampling gear was not selective and the probability of capture was equal among the mesh sizes appropriate to a species. The number of each species caught was assumed to have a multinomial distribution. If sampling effort were constant among species, the sample size would be equal to the total number of fish caught during the period. However, since a suite of gillnets was used, with 1, 2, 2, 2, and 3 gillnets fished for pink, sockeye, chum, coho, and Chinook salmon, respectively, catch was adjusted based on the relative sampling effort among species. The effective sample size is (C_{tk}).

$$C_{tk} = \sum_{i=1}^5 \sum_{j=1}^{j^t} \sum_{m=1}^3 \sum_{n=1}^6 u_{im} C_{ijkmn} w_i \quad (6)$$

where, $w_i = 2.0, 1.0, 1.0, 1.0$, and 0.67 for pink, sockeye, chum, coho, and Chinook salmon,

$$Var(\hat{S}_{itk}) = \frac{\hat{S}_{itk}(1 - \hat{S}_{itk})}{C_{tk} - 1} \quad (7)$$

respectively. The variance of \hat{S}_{itk} was estimated by:

BENDIX ESCAPEMENT ESTIMATES

Sonar counts for each area stratum (right and left bank, inshore and offshore) were apportioned to species for period t on a daily basis. Time period escapement estimates for each salmon species area stratum (\hat{N}_{itk}) were based on estimates of species proportions (\hat{S}_{itk}) from escapement sampling and period sonar counts (\hat{n}_{tk}):

$$\hat{N}_{itk} = \hat{S}_{itk} \hat{n}_{tk} \quad (8)$$

Time period escapement (\hat{N}_t) by species was estimated by summing area strata estimates:

$$\hat{N}_t = \sum_{k=1}^4 \hat{N}_{itk} \quad (9)$$

Since the Bendix counts continuously, there was no variance in estimates due to sampling, and counts were assumed to be known without error: Where n_{tk} was the sum of hourly counts during period t^k and its variance was assumed to be zero.

The variance of \hat{N}_{ijk} was estimated by:

$$Var(\hat{N}_{ijk}) = \hat{n}_{tk}^2 Var(\hat{S}_{itk}) \quad (10)$$

The total variance of, $V(\hat{N}_t)$, across all strata was estimated by:

$$V(\hat{N}_t) = \sum_{k=1}^4 Var(\hat{N}_{itk}) . \quad (11)$$

Cumulative numbers of salmon were calculated by summing daily estimates, and the total variance was equal to the sum of the daily variances.

DIDSON ESCAPEMENT ESTIMATES

Comparative estimates of species escapements and associated variances were estimated assuming the sampling design used for the DIDSON sonar system.

One 10-min count was completed per hour per stratum (left bank inshore, left bank offshore, right bank inshore, right bank offshore). The total count (\hat{n}_{tk}) for a period and stratum was:

$$\hat{n}_{tk} = \sum_{h=1}^{h^t} 6\hat{n}_{tkh} \quad (12)$$

where, \hat{n}_{tkh} = 10-min count during hour h within period t^k and stratum k . Note that there are j^{tk} days and h^{tk} hours in period t^k .

The between 10-min count variance was estimated using Wolter's (1984, 1985) V5 estimator for systematic sampling schemes. This was the least biased, most efficient estimator for tower counting (Reynolds et al. *In press*). Note that it is not possible to develop unbiased estimates of variance with a systematic sampling scheme (Cochran 1977; Wolter 1984, 1985). It was not feasible to implement stratified random sampling for the Nushagak because of limited crew sizes. The approximate variance estimators for systematic sampling are usually biased high (i.e., overestimate the precision of the escapement estimates); however, the bias was much less with the higher order V2, V3 and V4 estimators proposed by Wolter (1984, 1985) (Skalski et al. 1993).

$$Var(\hat{n}_{tkh}) = \frac{(1-f)}{h^{tk}(3.5(h^{tk}-4))} \sum_{h=1}^{h^{tk}} \left(\frac{n_{kh}}{2} - n_{kh-1} + n_{kh-2} - n_{kh-3} + \frac{n_{kh-4}}{2} \right)^2 \quad (13)$$

where, f = sampling rate.

$$Var(\hat{n}_{tkh}) = (6h^{tk})^2 Var(\hat{n}_{tkh}) \quad (14)$$

Sonar counts for each area stratum (left and right bank, inshore and offshore) were apportioned to species for the period t . The time period escapement estimates for each salmon species and area stratum (\hat{N}_{itk}) were based on estimates of species proportions (\hat{S}_{itk}) from escapement sampling and period sonar counts (\hat{n}_{tk}):

$$\hat{N}_{itk} = \hat{S}_{itk} \hat{n}_{tk} \quad (15)$$

The time period escapement (\hat{N}_it) by species was estimated by summing area strata estimates:

$$\hat{N}_{it} = \sum_{k=1}^4 \hat{N}_{itk} \quad (16)$$

The variance of \hat{N}_{ijk} (Goodman 1960) was estimated by:

$$Var(\hat{N}_{ijk}) = \hat{n}_{tk}^2 Var(\hat{S}_{itk}) + \hat{S}_{itk}^2 Var(\hat{n}_{tk}) - Var(\hat{n}_{tk}) Var(\hat{S}_{itk}) \quad (17)$$

The total variance, $V(\hat{N}_{it})$, across all strata was estimated by:

$$V(\hat{N}_{it}) = \sum_{k=1}^4 Var(\hat{N}_{itk}) \quad (18)$$

Cumulative numbers of salmon was calculated by summing daily estimates, and its total variance was equal to the sum of the daily variances.

AGE, SEX, SIZE, AND GENETIC SAMPLING

Age, sex, and length (ASL) data were collected from sockeye, Chinook, chum, and coho salmon migrating past the sonar site. Prior to 1995, only sockeye and chum salmon captured with beach seines were sampled for ASL data to avoid size selectivity associated with gillnets (Miller et al. 1994a, 1994b; Miller 1995). In 1992, Miller (1994a) found that, of the suite of mesh sizes fished, the 13.0- and 15.2-cm mesh gillnets both had length frequency distributions similar to the beach seine length frequency distribution, and that the 13.0-cm mesh gillnet sockeye salmon length frequency distribution most closely resembled that of the beach seine. In 1995, based on this information, sockeye salmon ASL data were collected from 13.0- and 15.2-cm mesh gillnets in addition to beach seines (Miller 1996). Beginning in 1996 and continuing through 2003, sockeye salmon ASL information was collected from 13.0-cm and 15.2-cm mesh gillnets and beach seines. Beginning in 2004 sockeye and chum salmon ASL information was collected from 13.0- and 15.2-cm mesh gillnets and beach seines. All Chinook and coho salmon captured were sampled to increase the sample sizes for these species, regardless of gear type, gillnet mesh size, or catch location.

Age was determined by examining scales (Mosher 1968). Scales were collected from the left side of the fish approximately 2 rows above the lateral line in an area crossed by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). Because of the high rate of scale regeneration among Chinook and coho salmon, 3 scales were collected from each fish. Only 1 scale per fish was collected from sockeye and chum salmon. Scales were mounted on gummed cards and impressions were made in cellulose acetate (Clutter and Whitesel 1956). European notation (Koo 1962) was used to record ages: Numerals preceding the decimal refer to the number of freshwater annuli and numerals following the decimal refer to the number of marine annuli. The total age of a fish, from the time of egg deposition, or brood year, is the sum of these 2 numbers plus 1 to account for incubation time.

Sampling goals by species for the entire season were 1,200 sockeye, 500 Chinook, 500 chum, and 250 coho salmon. Three time strata (early, middle and late) were desired for sockeye salmon; therefore, the goal for the season was set at 1,200.

The age and sex composition was estimated as a series of proportions p_{ias} defining a multinomial distribution for each age (a), sex (s), and species of salmon (i).

$$\hat{p}_{ias} = n_{ias} / n_{it} \quad (19)$$

where, n_{it} is the number of fish in the t th period and i th species sample and n_{ias} the number in the t th period and i th species sample of age a sex s . The marginal proportion was estimated for each combination of age and sex along with estimates of the proportions' variance (Cochran 1977):

$$Var(\hat{p}_{ias}) = \frac{\hat{p}_{ias}(1 - \hat{p}_{ias})}{n_{it} - 1} \quad (20)$$

The standard error of length (ℓ) by species, age, sex, and period of fish sampled in the escapement were calculated as:

$$se(\bar{\ell}_{iast}) = \frac{1}{n_{iast}} \sqrt{\frac{\sum_{k=1}^{n_{iast}} (\ell_{iastk} - \bar{\ell}_{iast})^2}{n_{iast} - 1}} \quad (21)$$

where, $\bar{\ell}_{iast}$ = mean length for species i , age a , sex s , and period t , ℓ_{iastk} = length of fish k of species i , age a , sex s , and period t , n_{iast} = number of fish of species i , age a , sex s , and period t .

Salmon were measured from the middle-of-the-eye to the fork-of-the-tail and lengths were recorded to the nearest 5 mm. Sex was determined from external characteristics for sockeye, Chinook, chum, and coho salmon.

Genetic samples, the axillary process near the pelvic fin, were collected from captured sockeye salmon migrating past the Nushagak sonar site to identify the different stocks returning to the Nushagak drainage.

MIGRATORY TIMING

The average proportions of passage by day for sockeye, Chinook, and chum salmon were calculated using all years that sonar data were available. Average daily proportions (\bar{p}_j) were calculated by summing daily proportions (p_{ji}) for all years used and dividing by total number of years used (Y):

$$\bar{p}_j = \frac{\sum_{i=1}^Y p_{ji}}{Y} \quad (22)$$

The average cumulative proportions by day were calculated by summing the average daily proportions through time.

The 2004 runs by species were compared to their desired goals at the sonar site through time by applying historical migratory timing to the goals. The average daily cumulative proportions for each species were multiplied by their respective escapement goals (550,000 for sockeye salmon, 75,000 for Chinook salmon, 100,000 for coho salmon, and 900,000 for pink salmon). Currently there is no escapement goal for chum salmon. The management escapement objective is 190,000 chum salmon.

ENVIRONMENTAL DATA

Weather data was collected at approximately 0800 and 2000 hours each day. Precipitation was measured to the nearest mm using a Taylor Clear View rain gauge, air temperatures were measured to the nearest 0.1 C using an Oregon Scientific digital thermometer, and wind direction and velocity (km/h) were measured using a Weathertronics anemometer.

RESULTS

HYDROACOUSTIC COUNTING

Hydroacoustic counting began in all strata on 8 June and ended 16 August. A total of 1,600,620 counts were recorded in 2004 (Table 1). Sonar count distribution by bank varied throughout the season with counts at the end of the season totaling 663,094 (41%) on the left bank and 937,526 (59%) on the right bank. The inshore strata accounted for the majority of all sonar counts; the left bank inshore stratum accounted for 94% of all left bank counts, while the right bank inshore stratum accounted for 94% of all right bank sonar counts (Appendices A1–A4).

Spatial Distribution of Sonar Counts

From 8 June to 24 July, sockeye, Chinook, and chum salmon, were the primary species present. Sockeye, Chinook, and chum salmon passage distribution in the left bank inshore stratum varied through time, with 83% of counts occurring in sectors 4–9, approximately 4.0–9.1 m from the transducer face (Figure 2; Appendix A1). Peak daily passage in the left bank inshore stratum occurred on 20 June. Most counts (98%) in the left bank offshore strata were observed in the first half of the offshore counting range occurring within approximately 9.1 m of the transducer face (Figure 3; Appendix A2). Peak passage in the left bank offshore stratum occurred on 13 June.

Sockeye, Chinook, and chum salmon passage distribution in the right bank inshore stratum sectors varied through time, with 90% of counts occurring in sectors 3–8, approximately 2.4–6.4 m from the transducer face (Figure 4; Appendix A3). Peak daily passage in the right bank inshore stratum occurred on 1 July. For sonar counts during this time period observed in the right bank offshore strata, 53% occurred in sectors 3, 4, 9, and 10, with the remaining counts distributed evenly throughout the remaining offshore sectors (Figure 5; Appendix A4). Peak passage in the right bank offshore stratum occurred on 1 July.

Coho and pink salmon were the primary species present from 25 July through 16 August. Sonar count distribution for the left bank inshore stratum experienced 98% of the total left bank counts, inshore and offshore, with 90% of the counts occurring in sectors 1–6 of the left bank inshore counting range within approximately 6.0 m of the transducer face (Figures 6 and 7; Appendices A1 and A2). The daily peak of 34,195 counts for the left bank inshore counting range occurred on 8 August. Left bank offshore distribution of sonar counts occurred only in the first half of the counting range. The peak daily count on the left bank offshore stratum occurred on 12 August.

During the period of coho and pink salmon passage, the right bank inshore stratum experienced 93% of the total sonar counts throughout the counting range, inshore and offshore, with 99% of the counts occurring in sectors 1–6 of the right bank inshore strata within approximately 4.8 m of the transducer face (Figures 8 and 9; Appendices A3 and A4). Several daily peaks in sonar counts occurred in the right bank inshore stratum, with the largest peak of 45,373 counts occurring on 3 August. Count distribution during this time period in the right bank offshore strata

indicates that most counts occurred within the first and last 4 sectors of the counting range. The peak daily count occurred on 27 July in the right bank offshore stratum.

Temporal Distribution of Sonar Counts

Hourly fish passage from 8 June through 24 July varied within and among strata during this period. Peak counts in the left bank inshore stratum varied, with the largest sonar counts occurring between 2200 and 0100 hours, and the lowest passage rate occurring at 1900 hours (Figure 10). The left bank offshore stratum experienced peak fish passage between 0500 and 0900 hours, with the lowest passage rate occurring at 1400 hours and between 1800 and 2000 hours (Figure 10).

Sonar counts in the right bank inshore stratum also varied, with peak counts occurring between 0100 and 0300 hours, with the lowest passage rates occurring between 1000 and 1100 hours (Figure 11). The right bank offshore stratum experienced peak passage from 0300 to 0500 hours, with the lowest passage rates occurring between 1000 and 1500 hours (Figure 11).

From 25 July through 16 August, hourly fish passage during this time period varied between both inshore strata, but exhibited a pattern of fish passage similar to the offshore strata. The left bank inshore stratum passage rates started increasing at 1000 hours and peaked between 1300 and 1900 hours, and the lowest passage rates occurred between 0600 and 0900 hours (Figure 12). A temporal trend in the passage rate occurred in the left bank offshore stratum as passage rates increased from 0100 through 0600 hours and decreased throughout the remainder of the day (Figure 12).

The right bank inshore stratum experienced the lowest passage from 0100 to 0600 hours, and higher passage rates in the morning between 0700 and 0900 hours. Right bank inshore stratum afternoon and evening passage was relatively consistent, with peak passage occurring at 2000 hours (Figure 13). The temporal passage trend in the right bank offshore stratum was similar to the trend in the left bank offshore stratum, occurred in the right bank offshore stratum with peak passage rates between 0100 and 0600 hours, and low passage rates during the remainder of the period (Figure 13).

Escapement Sampling

In 2004, a total of 3,913 gillnet drifts were completed. The duration of each gillnet drift was approximately 2.5 minutes. The 20.6-cm, 15.2-cm, 13.0-cm, and 11.4-cm mesh gillnets caught 415, 1,385, 1,441, and, 494 salmon, respectively (Tables 2 and 3). The total gillnet catch of 3,735 fish was composed of 1,010 sockeye salmon, 980 Chinook salmon, 788 chum salmon, 294 coho salmon, and 663 pink salmon. Most salmon were caught in the right bank inshore stratum (1,148) followed by the left offshore (904), right offshore (901), and left inshore (782) strata (Tables 2 and 3).

The 15.2-cm gillnet caught the greatest number of sockeye salmon (457), followed by the 13.0-cm (425), 20.6-cm (118), and 11.4-cm (10) mesh gillnets. Chinook salmon were captured predominantly in the 15.2-cm mesh gillnet (406), followed by the 13.0-cm mesh gillnet (323), and 20.6-cm mesh gillnet (240). Chum salmon were caught predominantly in both the 15.2-cm mesh gillnet (363), and 13.0-cm mesh gillnet (342), followed by the 20.6-cm mesh gillnet (56), and 11.4-cm (27) mesh gillnets. Coho salmon were predominately caught in the 13.0-cm mesh (121), and 11.4-cm (110) mesh gillnets. Pink salmon were caught in the greatest number using the 11.4-cm (336) mesh gillnet followed by the 13.0-cm (230) mesh gillnet (Tables 2 and 3).

Sockeye, Chinook, and chum salmon dominated the drift gillnet escapement sampling catch throughout June and most of July while coho and pink salmon were the predominant species caught during the last week of July through 15 August (Tables 4–7).

Estimates of Escapement

The overall salmon escapement estimate for the Nushagak River in 2004 was 1,600,620 fish (Standard Error (SE) = 25,198). This included an estimated 491,730 sockeye (SE = 12,292), 116,400 Chinook (SE = 7,694), 283,811 chum (SE = 12,791), 152,613 coho (SE = 10,816), and 556,066 pink (SE = 12,002), salmon (Table 8).

Sockeye Salmon

Sockeye salmon were estimated passed the sonar site from 12 June to 8 August (Table 9; Figure 14). Peak daily passage was from 20 June to 8 July, with the largest daily escapement of 45,691 sockeye salmon estimated on 1 July.

Sockeye salmon passage distribution varied by bank and among strata through time. The left (south) bank escapement estimate of 179,000 sockeye salmon was 36.4% of the total sockeye salmon escapement. The left bank inshore stratum escapement estimate of 176,173 sockeye salmon was 98.4% of the left bank escapement. The left bank offshore stratum accounted for 1.6% of the left bank escapement with an estimated 2,827 sockeye salmon passing. Peak daily left bank sockeye salmon passage occurred in the inshore stratum from 19 June to 26 June, with the largest daily passage of 19,875 occurring on 20 June, and another slightly smaller peak of 19,104 on 7 July.

The right (north) bank escapement estimate of 312,730 sockeye salmon was 63.6% of the total sockeye salmon escapement. The right bank inshore stratum escapement estimate of 305,509 sockeye salmon was 97.7% of the right bank and 62.1% of the total sockeye salmon escapement. The right bank offshore stratum accounted for 2.3% of the right bank and 1.5% of the total with an estimated escapement of 7,222 sockeye salmon. Peak daily sockeye salmon passage on the right bank occurred in the inshore stratum from 24 June to 8 July, with the largest daily passage of 37,418 occurring on 1 July.

Chinook Salmon

Chinook salmon were estimated passing the sonar site immediately following installation of the sonar equipment on 8 June (Table 10; Figure 15). Chinook salmon daily passage peaked on 19 June with an estimated count of 20,395 fish.

Chinook salmon passage distribution varied by bank and among strata through time. The left (south) bank escapement estimate of 76,993 Chinook salmon was 66.1% of the total escapement. The left bank inshore stratum escapement estimate of 50,422 Chinook salmon was 65.5% of the left bank escapement. The left bank offshore stratum accounted for 34.5% of the left bank escapement, with an estimated 26,571 Chinook salmon passing. Peak daily left bank Chinook salmon passage occurred in the inshore stratum from 19 June to 24 June, with the largest daily passage of 11,466 occurring on 19 June.

The right (north) bank escapement estimate of 39,407 Chinook salmon was 33.9% of the total Chinook salmon escapement. The right bank inshore stratum escapement estimate of 30,504 Chinook salmon was 77.4% of the right bank escapement. The right bank offshore stratum accounted for 22.6% of the right bank total, with an estimated escapement of 8,903 Chinook

salmon. Peak daily Chinook salmon passage on the right bank occurred in the inshore stratum from 17 June to 21 June, with the largest daily passage of 7,204 occurring on 19 June.

Chum Salmon

Chum salmon were estimated passing the sonar site from 12 June to 9 August (Table 11; Figure 16). Chum salmon daily passage peaked on 20 June, when an estimated 46,225 chum salmon passed the sonar site.

Chum salmon passage distribution varied by bank and among strata through time. The left (south) bank escapement estimate of 97,124 chum salmon was 34.2% of the total escapement. The left bank inshore stratum escapement estimate of 90,126 chum salmon was 92.8% of the left bank escapement. The left bank offshore stratum accounted for 7.2% of the left bank escapement, with an estimated 6,998 chum salmon. Peak daily left bank chum salmon passage occurred in the inshore strata from 19 June to 24 June, with the largest daily passage of 15,458 occurring on 20 June.

The right (north) bank escapement estimate of 186,687 chum salmon was 65.8% of the total chum salmon escapement. The right bank inshore stratum escapement estimate of 174,109 chum salmon was 93.3% of the right bank escapement. The right bank offshore accounted for 6.7% of the right bank total, with an estimated escapement of 12,579 chum salmon. Peak daily chum salmon passage on the right bank occurred in the inshore stratum from 17 June to 2 July, with the largest daily passage of 29,800 occurring on 20 June.

Coho Salmon

Coho salmon were estimated passing the sonar site from 17 July to 16 August (Table 12; Figure 17). Coho salmon daily passage peaked on 14 August, when an estimated 39,240 coho passed the sonar site.

Coho salmon passage distribution varied by bank and among strata through time. The left (south) bank escapement estimate of 88,691 coho salmon was 58.1% of the total escapement. The left bank inshore stratum escapement estimate of 87,150 coho salmon was 98.3% of the left bank escapement. The left bank offshore stratum accounted for 1.7% of the left bank escapement, with an estimated 1,541 coho salmon passing. Peak daily left bank coho salmon passage occurred in the inshore stratum from 8 August to 16 August, with the largest daily passage of 28,808 occurring on 13 August.

The right (north) bank escapement estimate of 63,921 coho salmon was 41.9% of the total coho salmon escapement. The right bank inshore stratum escapement estimate of 54,971 coho salmon was 86.0% of the right bank escapement. The right bank offshore stratum accounted for 14.0% of the right bank total, with an estimated escapement of 8,950 coho salmon. Peak daily coho salmon passage on the right bank occurred in the inshore stratum from 25 July to 28 July, with the largest daily passage of 11,864 occurring on 26 July, and again from 3 August to 16 August, with the largest daily passage of 8,832 occurring on 14 August.

Pink Salmon

Pink salmon were estimated passing the sonar site from 24 July to 16 August (Table 13; Figure 18). Peak daily passage occurred 7 August, with an estimated 68,645 pink salmon passing the sonar site.

Pink salmon passage distribution varied by bank and among strata through time. The left (south) bank escapement estimate of 221,286 pink salmon was 39.8% of the total escapement. The left bank inshore stratum escapement estimate of 218,368 pink salmon was 98.7% of the left bank escapement. The left bank offshore stratum accounted for 1.3% of the left bank escapement, with an estimated 2,918 pink salmon. Peak daily left bank pink salmon passage occurred in the inshore stratum from 7 August to 13 August, with the largest daily passage of 32,313 occurring on 7 August.

The right (north) bank escapement estimate of 334,780 pink salmon was 60.2% of the total pink salmon escapement. The right bank inshore stratum escapement estimate of 319,728 pink salmon was 95.5% of the right bank escapement. The right bank offshore accounted for 4.5% of the right bank total, with an estimated escapement of 15,052 pink salmon. Peak daily pink salmon passage on the right bank occurred in the inshore stratum from 29 July to 8 August, with the largest daily passage of 43,703 occurring on 3 August.

Age, Sex, and Size Estimates

Sockeye salmon age, sex, and length composition were estimated based on 739 readable scales from 968 fish sampled during the season, therefore, age composition estimates for sockeye salmon were made for only 2 periods, rather than 3, for the season 2004 (Table 14).

The dominant age class for sockeye salmon during period one, 8 June to 2 July, was age-1.3 (67.5%; 1999 brood year), followed by age-1.4 (13.3%; 1998 brood year), and age-1.2 (11.2%; 2000 brood year). The sex composition of sockeye salmon during this time was 58.9% males and 41.1% females. The mean length by age ranged from 450 mm for age-0.2 to 593 mm for age-1.4 (Table 15). The dominant age class for sockeye salmon during period two, 3 July–16 August, was age-1.3 (53.8%), followed by age-1.2 (29.2%), and age-1.4 (8.8%). The sex composition of sockeye salmon during this time was 54.7% males to 45.3% females. The mean length by age ranged from 452 mm for age-0.2 to 632 mm for age-1.4 (Table 15). For both periods combined, the dominant age class was age-1.3 (62.4%), followed by age-1.2 (17.9%), and age-1.4 (11.6%). The overall sex composition of sockeye salmon was 57.4% males and 42.6% females. Mean length by age ranged from 450 mm for age-0.2 to 604 mm for age-1.4 (Table 15).

Chinook salmon age, sex, and length composition were estimated based on 546 readable scales from 601 fish sampled during the season (Table 16). Three major age classes were present: age-1.2 (24.2%; 2000 brood year); age-1.3 (42.5%; 1999 brood year); and age-1.4 (32.4%; 1998 brood year). The sex composition of Chinook salmon was 63.7% males and 36.3% females. The mean length by age ranged from 592 mm for age-1.2 to 883 mm for age-1.5 Chinook salmon (Table 17).

Chum salmon age, sex, and length composition were estimated based on 527 readable scales from 599 fish sampled during the season (Table 18). The dominant age class was age-0.4 (56.7%; 1999 brood year), followed by age-0.3 (39.7%; 2000 brood year). The sex composition of chum salmon was 62.3% males and 37.7% females. The mean length by age ranged from 555 mm for age-0.2 to 607 mm for age-0.4 fish (Table 19).

Coho salmon age, sex and length composition were estimated based on 219 readable scales from 294 fish sampled during the season (Table 20). The dominant age class was age-2.1 (88.1%; 2000 brood year), followed by age-1.1 (9.6%; 2001 brood year). The sex composition of coho salmon was 58.7% males and 41.3% females. The mean length by age ranged from 485 mm for age-1.1 to 589 mm for age-3.1 fish (Table 21).

Sonar operations were not affected by climatic conditions in 2004. Air and water temperature was slightly above average throughout the season (Table 22; Appendix B1).

Genetic Sampling

A total of 689 genetic samples were collected from sockeye salmon passing the sonar site from 12 June to 18 July (Table 23). The samples were sent to the ADF&G Gene Conservation Lab in Anchorage for later analysis.

BENDIX-DIDSON COMPARISON

2003

During the 2003 field season, the standard DIDSON was deployed on the left (south) bank of the Nushagak River in a comparative study alongside the Bendix. A total of 120,926 Bendix and 166,236 DIDSON daily paired hourly counts were recorded from 26 June to 19 July (Figure 19; Appendix C1). The Bendix counts were 27.3% lower (45,310) than the DIDSON counts.

Sonar count distribution by left bank strata varied throughout the comparison study period. Inshore stratum Bendix counts (98,189) were 35.6% less than DIDSON counts (152,574) (Figure 19; Appendix C2). Offshore stratum Bendix counts (22,737) were 66.4% greater than DIDSON counts (13,663) (Figure 19; Appendix C3). Left bank strata daily and hourly counts are presented in Appendices C4–C7.

Escapement estimates from sonar counts by species for the left bank were compared during the study period. Sockeye salmon escapement estimates were 35.2% or 31,710 lower for Bendix counts (58,330) than DIDSON counts (90,040) (Appendix C8). Inshore stratum Bendix counts (56,838) were 36.2% less than DIDSON counts (89,045) (Appendix C9). Offshore stratum Bendix counts (1,492) were 50.0% greater than DIDSON counts (995) (Appendix C9).

Chinook salmon escapement estimates were 40.9% or 6,147 higher for Bendix counts (21,186) than DIDSON counts (15,039) (Appendix C8). Inshore stratum Bendix counts (3,955) were 22.6% less than DIDSON counts (5,588) (Appendix C9). Offshore stratum Bendix counts (17,231) were 73.6% greater than DIDSON counts (9,927) (Appendix C9).

Chum salmon escapement estimates were 32.3% or 19,748 lower for Bendix counts (41,409) than DIDSON counts (61,157) (Appendix C8). Inshore stratum Bendix counts (37,396) were 36.0% less than DIDSON counts (58,416) (Appendix C9). Offshore stratum Bendix counts (4013) were 46.4% greater than DIDSON counts (2,741) (Appendix C9).

2004

During the 2004 field season, the standard DIDSON was again deployed on the left (south) bank of the Nushagak River in a comparative study alongside the Bendix. A total of 475,486 DIDSON and 409,875 Bendix daily paired hourly counts were recorded from 12 June to 7 August (Figure 20; Appendix C10). The Bendix counts were 13.8% lower (65,611) than the DIDSON counts.

Sonar count distribution by left bank strata varied throughout the comparison study period. Inshore stratum Bendix counts (382,257) were 0.1% greater than DIDSON counts (381,859) (Figure 20; Appendix C11). Offshore stratum Bendix counts (27,618) were 70.5% less than DIDSON counts (93,627) (Figure 20; Appendix C12). Left bank strata daily and hourly counts are presented in Appendices C13 through C16.

Escapement estimates from sonar counts by species for the left bank were compared during the study period. Sockeye salmon escapement estimates were 11.6% or 15,792 greater for Bendix counts (151,934) than DIDSON counts (136,142) (Appendix C17). Inshore stratum Bendix counts (149,757) were 15.6% greater than DIDSON counts (129,526) (Appendix C18). Offshore stratum Bendix counts (2,177) were 67.1% less than DIDSON counts (6,616) (Appendix C18).

Chinook salmon escapement estimates were 40.2% or 41,745 less for Bendix counts (62,167) than DIDSON counts (103,911) (Appendix C17). Inshore stratum Bendix counts (43,694) were 10.7% less than DIDSON counts (48,936) (Appendix C18). Offshore stratum Bendix counts (18,472) were 66.4% less than DIDSON counts (54,976) (Appendix C18).

Chum salmon escapement estimates were 8.0% or 7,831 less for Bendix counts (90,452) than DIDSON counts (98,283) (Appendix C17). Inshore stratum Bendix counts (85,643) were 6.4% greater than DIDSON counts (80,480) (Appendix C18). Offshore stratum Bendix counts (4,810) were 73.0% less than DIDSON counts (17,804) (Appendix C18).

Coho salmon escapement estimates were 22.5% or 2,021 less for Bendix counts (6,945) than DIDSON counts (8,966) (Appendix C17). Inshore stratum Bendix counts (6,452) were 1.5% less than DIDSON counts (6,550) (Appendix C18). Offshore stratum Bendix counts (493) were 79.6% less than DIDSON counts (2,416) (Appendix C18).

Pink salmon escapement estimates were 23.3% or 29,807 less for Bendix counts (98,377) than DIDSON counts (128,184) (Appendix C17). Inshore stratum Bendix counts (96,710) were 16.9% less than DIDSON counts (116,367) (Appendix C18). Offshore stratum Bendix counts (1,667) were 85.9% less than DIDSON counts (11,817) (Appendix C18).

DISCUSSION

The purpose of this study was to estimate the escapement of Pacific salmon into the Nushagak River using hydroacoustics. The 2004 season was operated similarly to years past and was successful in providing needed inseason escapement estimates to area managers.

The primary objective (Objective 1) of this study was achieved for sockeye and chum salmon in 2004. The primary objective (Objective 1) for Chinook salmon was just outside the parameter and was not met for coho salmon. The escapement estimate of 491,730 sockeye salmon had a 90% Confidence Interval (CI) of $\pm 20,160$ fish. The 90% CI was within 4.1% of the escapement estimate. In addition, the escapement estimate of 491,730 sockeye salmon was within the biological escapement goal (BEG) range of 340,000 to 760,000 sockeye salmon. The run timing of sockeye salmon in 2004 was 4 days earlier than the 1990–2003 average timing (Table 9; Figure 14). The escapement estimate of 116,400 Chinook salmon had a 90% CI of $\pm 12,617$ fish. The 90% CI was within 10.8% of the escapement estimate. In addition, the escapement estimate of 116,400 Chinook salmon exceeded the escapement goal of 75,000 fish. Cumulative Chinook salmon escapement run timing in 2004 was 3 days earlier than the 1990–2003 average timing (Table 10; Figure 15). The escapement estimate of 283,811 chum salmon had a 90% CI of $\pm 20,977$ fish. The 90% CI was within 7.4% of the escapement estimate. There is no formal escapement goal for chum salmon in the Nushagak River; the escapement estimate of 283,811 exceeded the management escapement objective of 190,000 fish. Cumulative chum salmon escapement in 2004 was above the 10-year (1990–1999) average and below the 2000–2003 average (Table 11; Figure 16). The run timing of chum salmon in 2004 was 10 days earlier than the

10-year (1990–1999) average and 7 day earlier than the 2000–2003 average (Table 11; Figure 16). The escapement estimate of 152,613 coho salmon had a 90% CI of \pm 17,738 fish. The 90% CI was within 11.6% of the escapement estimate. In addition, the escapement estimate of 152,613 coho salmon exceeded the escapement goal of 100,000 fish. Cumulative coho salmon escapement run timing in 2004 was 7 days later than the (1990–2002) average timing (Table 12; Figure 17). The escapement estimate of 556,066 pink salmon had a 90% CI of \pm 19,683 fish. The 90% CI was within 3.5% of the escapement estimate. The escapement estimate of 556,066 pink salmon was below the escapement goal range of 600,000 to 1,100,000 for pink salmon. Cumulative pink salmon escapement in 2004 was above the 10-year (1990–1998) average and above the 2000–2002 average (Table 13; Figure 18).

Sampling efforts to estimate the age composition for sockeye salmon were not adequate to meet Objective 2. A sample size goal for the season was set at 1,200 sockeye salmon with 400 fish sampled from 3 time strata (early, middle, and late). A total of 968 sockeye salmon were sampled producing 739 readable scales during all of 2004. This was only 62% of the sampling goal of 1,200. Therefore, only 2 age composition estimates for the entire season were made for sockeye salmon in 2004. Sampling efforts should be increased in the future to adequately sample sockeye salmon to obtain age composition estimates for the early, middle and late portions of the escapement (Table 14).

Sampling efforts to estimate the age composition for Chinook salmon were adequate to meet Objective 2 for Chinook salmon. A sample size goal for Chinook salmon was set at 500 fish. A total of 601 Chinook salmon were sampled producing 546 readable scales during 2004. Age composition estimates were made for all the major age classes of Chinook salmon such that all the 90% CI's were within 5% of the age composition estimates (Table 16).

Sampling efforts to estimate the age composition for chum salmon were adequate to meet Objective 2 for chum salmon. A sample size goal for chum salmon was set at 500 fish. A total of 599 chum salmon were sampled producing 527 readable scales during 2004. Age composition estimates were made for all the major age classes of chum salmon such that all the 90% CI's were within 5% of the age composition estimates (Table 18).

Sampling efforts to estimate the age composition for coho salmon were not adequate to meet Objective 2 for coho salmon. A sample size goal for coho salmon was set at 500 fish. A total of 302 coho salmon were sampled producing 219 readable scales during 2004. Age composition estimates were made for all the major age classes of coho salmon such that all the 90% CI's were within 5% of the age composition estimates. Sampling efforts should be increased in the future to adequately sample coho salmon for age composition estimates (Table 20).

Estimates of the sex composition for sockeye, Chinook, chum, and coho salmon were made during 2004 (Objective 3). The total proportion of males (57.4%) was greater than females (42.6%) for sockeye salmon in 2004 (Table 15). However, we were not able to look at changes in the sex composition of sockeye salmon during the season because we were not able to obtain enough samples during the early, middle, and late portion of the escapement. There were more males than females in Chinook (63.7% males; 36.3% females; Table 17), chum (62.3% males; 37.7% females; Table 19), and coho (58.7% males; 41.3% females; Table 21) salmon escapements during 2004.

Estimates of mean length at age by sex were made for sockeye, Chinook, chum, and coho salmon escapement during 2004 (Objective 4). Males were larger than females for sockeye salmon (mean length: 561 mm, males; 547 mm, females; Table 15). However, for Chinook salmon males were

smaller than females (mean length: 707 mm, males; 798 mm, females; Table 17). Males were larger than females for Chum salmon (mean length: 611 mm, males; 579 mm, females; Table 19). For coho salmon, females were larger than males (mean length: 539 mm, males; 550 mm, females; Table 21).

Species passage by bank was compared from previous years. Sockeye salmon passage in 2004 was similar to the past 2 seasons with 98.0% of the passage occurring in the left and right bank inshore strata while averaging 98.3% of the passage from 2002–2004. Over the past 3 seasons (2002–2004) sockeye passage on the right bank inshore has averaged 69.6% of the total sockeye escapement.

Chinook salmon passage in 2004 was also similar to previous years with 66.1% of the passage occurring in the left bank strata. Over the past 3 seasons (2002–2004), Chinook salmon passage on the left bank has averaged 69.6% of the total Chinook escapement.

Chum salmon passage in 2004 was also similar to previous years with 61.3% of the passage occurring in the right bank inshore strata. Over the past 3 seasons (2002–2004) chum passage on the right bank inshore has averaged 61.0% of the total chum escapement.

Coho and pink salmon passage by left and right bank in 2004 was opposite of what occurred in 2002, the last time coho and pink salmon were estimated. In 2004 most coho (58.1%) where estimated passing the left bank while in 2002 (60.4%) where estimated on the right bank. Pink salmon in 2004 where estimated passing mainly on the right bank (60.2%) while in 2002 (64.4%) of the passage was on the left bank.

New sample sizes to estimate species composition continued to be used in 2004 (Appendix D1). It was determined in 2002 that using a sample size of 5 fish to estimate species composition during a report period had minimal effects on the daily estimates and was less biased and more accurate (McKinley 2003). This method also had a tremendous advantage of providing almost daily estimates of escapement that did not change retroactively. Prior to 2002, a total of 100 salmon had to be caught prior to estimating species composition during a report period. This created a situation where preliminary species composition estimates were made over many days until 100 salmon were caught. After 100 salmon were caught, the preliminary species composition estimates were retroactively updated during the season. This created a situation where numerous changes were being made to the escapement estimates for all species during the season. With the implementation of the new apportionment report pooling of 5 fish, we were able to provide daily estimates to fishery managers and the public. This was a tremendous success and was much less confusing than in years past. The one downside to the reduction in sample size from 100 fish to 5 fish having to be caught during a report period was the increase in variance estimates for the species composition estimates.

Bendix-DIDSON Comparison

Total Bendix counts were less than DIDSON counts during both years of the study. Bendix had 27.3 (45,310) less total counts than DIDSON in 2003, while in 2004, Bendix had 13.8% (65,611) less total counts than DIDSON. Total counts also varied by species and among strata in 2003 and 2004.

Sockeye salmon counts by Bendix were 35.2% (31,710) less than DIDSON in 2003; Bendix was 11.6% (15,792) greater than DIDSON in 2004. The difference was greater in 2003. Counts for both Bendix and DIDSON were similar in 2004. The largest difference in 2003 and 2004 occurred in the inshore area because a majority of sockeye salmon were counted in the inshore area.

Chinook salmon counts by Bendix were 40.9% (6,147) greater than DIDSON in 2003, while Bendix was 40.2% (41,745) less than DIDSON in 2004. The difference in counts in 2004 was greater than 2003. The largest difference in 2004 occurred in the offshore strata. Inshore counts were similar during both years.

Chum salmon counts by Bendix were (32.3%) 19,748 less than DIDSON in 2003, while Bendix was (8.0%) 7,831 less than DIDSON in 2004. The difference in counts in 2003 was greater than in 2004. This was similar to what was observed for sockeye salmon.

The primary reasons for the differences between Bendix and DIDSON counts were due to the increased detectability of the DIDSON and operation of the Bendix. The multi-beam DIDSON offers superior detection capabilities over the conventional single narrow beam of Bendix transducers when aimed along an uneven or nonlinear substrate because 1) the DIDSON beam can be aimed into the substrate because its bottom-subtraction feature can remove stationary structure from the image, and 2) the wider vertical beam offers greater coverage of the water column, both horizontally and vertically (Burwen et al. 2007).

Operation of the Bendix, aiming and calibration, may have contributed to part of the difference in the counts between the 2 sonar types. Proper aiming of the Bendix transducers is one of the most critical aspects of the operation. A transducer that is aimed a couple of degrees off could cause fish to not be counted. Also, the accuracy of Bendix counts was dependent on daily calibrations during different rates of fish passage. Improper or lack of calibration during different rates of fish passage could cause the Bendix to under or over count.

Additional advantages offered by the DIDSON were the near video, high resolution, images. The DIDSON was much easier to aim than the Bendix sonar. In addition, the direction of fish travel, both upstream and downstream, can be determined with the DIDSON, but not with the Bendix. Finally, we have the ability to store raw data files with the DIDSON, which can be reviewed at later a date, while the Bendix system was designed to only produce a final count with no storage mechanism for the raw signal.

RECOMMENDATIONS

We recommend that the short range DIDSON replace the Bendix system for estimating salmon escapement on the left (south) bank in 2005. We further recommend that testing continue with the long range (LR) DIDSON on the right bank. In addition, DIDSON training should be conducted for all sonar personnel. Finally, we recommend that additional comparisons be conducted between Bendix and DIDSON (both short and long range) to provide a better understanding of how the 2 systems compare in the future.

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REFERENCES CITED

- Brannian, L. K., S. J. Fleischman, J. D. Miller, and B. A. Cross. 1995. Evaluation of escapement estimation procedures for Pacific salmon into the Nushagak River as applied to the 1991 run. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fisheries Report 95-01, Juneau.
- Belcher, E. O., B. Matsuyama, and G. R. Trimble. 2001. Object identification with acoustic lenses. Proceedings of MTS/IEEE Oceans 2001, Honolulu, Hawaii. 1:5-8.
- Belcher, E. O., W. Hanot, and J. Burch. 2002. Dual-Frequency identification sonar. Pages 187-192 in Proceedings of the 2002 International Symposium on underwater technology. Tokyo, Japan, April 16-19.
- Burwen, D. L., S. J. Fleischman, and J. D. Miller. 2007. Evaluation of a dual-frequency imaging sonar for estimating fish size in the Kenai River. Alaska Department of Fish and Game, Fishery Data Series No. 07 44, Anchorage. <http://www.sf.adfg.state.ak.us/FedAidPDFs/fds07-44.pdf>
- Clutter, R., and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. International Pacific Salmon Commission, Bulletin 9. Westminster, British Columbia, Canada.
- Cochran, W. G. 1977. Sampling techniques, *third edition*. John Wiley and Sons, New York.
- Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 55:708-713.
- INPFC (International North Pacific Fisheries Commission). 1963. Annual report, 1961. International North Pacific Fisheries Commission, Vancouver, British Columbia.
- King, B. E., and K. E. Tarbox. 1989. Upper Cook Inlet salmon escapement studies, 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fisheries Report 89-19, Juneau.
- Koo, T. S. Y. 1962. Age designation in salmon. Pages 37-48 in T. S. Y. Koo, editor. Studies of Alaska red salmon. University of Washington Publications in Fisheries, Seattle.
- Maxwell, S. L., and N. E. Gove. 2002. The feasibility of estimating migrating salmon passage rates in turbid rivers using a dual frequency identification sonar (DIDSON) 2002. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report 2A04-05, Anchorage.
- Maxwell, S. L., T. M. Willette, and A. V. Smith. *In prep.* A comparison of salmon passage rates from two sonars, a dual frequency identification sonar (DIDSON) and Bendix Counter, at the Copper, Kenai, and Nushagak Rivers. Alaska Department of Fish and Game, Fishery Manuscript, Anchorage.
- McBride, D. N. 1981. Nushagak River sonar enumeration studies, 1979. *Appendix A* in Nushagak sonar enumeration project, 1980. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 83, Anchorage.
- McKinley, W. L. 2003. Sonar enumeration of Pacific salmon into the Nushagak River, 2002. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report 2A03-05, Anchorage.
- Miller, J. D. 1995. Sonar enumeration of Pacific salmon into Nushagak River, 1994. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 2A95-10, Anchorage.
- Miller, J. D. 1996. Sonar enumeration of Pacific salmon into Nushagak River, 1995. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 2A96-08, Anchorage.
- Miller, J. D., L. K. Brannian, and B. A. Cross. 1994a. Sonar enumeration of Pacific salmon into Nushagak River and evaluation of species composition estimates, 1992. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Technical Fisheries Report 94-06, Juneau.
- Miller, J. D., L. K. Brannian, and B. A. Cross. 1994b. Sonar enumeration of Pacific salmon into the Nushagak River, 1993. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report 2A94-20, Anchorage.

REFERENCES CITED (Continued)

- Minard, R. E. 1985. Nushagak sonar salmon enumeration project, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 85-3, Anchorage.
- Minard, R. E., and M. Frederickson. 1983. Nushagak River sonar salmon enumeration project, 1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Bristol Bay Data Report 97, Anchorage.
- Mosher, K. H. 1968. Photographic atlas of sockeye salmon scales. U.S. Fish and Wildlife Service, Fishery Bulletin 67:243-280.
- Reynolds, J. H., C. A. Woody, N. E. Gove, and L. F. Fair. *In press*. Efficiently estimating salmon escapement uncertainty using systematically sampled data. *In* C. A. Woody, editor. *Sockeye salmon ecology, evolution, and management*. American Fisheries Society, Symposium No. 54, Bethesda, Maryland.
- Robertson, T. L. 1984. Assessment of the upstream limit of multiple stock mixing of sockeye salmon stocks within the lower Nushagak River, Alaska. Alaska Department of Fish and Game, Informational Leaflet No. 242, Juneau.
- Skalski, J. R., A. Hoffman, B. H. Ransom, and T. W. Steig. 1993. Fixed-location hydroacoustic monitoring designs for estimating fish passage using stratified random and systematic sampling. Canadian Journal of Fisheries and Aquatic Sciences 50:1208-1221.
- Wolter, K. M. 1984. An investigation of some estimators of variance for systematic sampling. Journal of the American Statistical Association 79(388):781-790.
- Wolter, K. M. 1985. Introduction to variance estimation. Springer-Verlag, New York, 427 p.

TABLES AND FIGURES

Table 1.—Daily inshore and offshore sonar counts by bank, Nushagak River sonar project, 2004.

Date	Left Bank		Right Bank	
	Inshore	Offshore	Inshore	Offshore
6/08	317	150	193	0
6/09	374	342	375	28
6/10	1,004	147	98	17
6/11	780	180	102	4
6/12	902	2,253	1,977	177
6/13	2,358	3,189	2,045	200
6/14	1,489	795	676	129
6/15	491	252	1,292	52
6/16	862	268	1,806	54
6/17	2,721	909	11,865	221
6/18	1,424	825	10,350	371
6/19	30,354	1,639	21,972	958
6/20	41,248	2,206	41,606	1,321
6/21	21,570	1,296	14,509	218
6/22	11,675	782	10,360	156
6/23	20,277	1,115	7,537	218
6/24	34,137	2,744	27,204	499
6/25	15,582	868	22,094	195
6/26	8,036	882	11,522	762
6/27	4,573	595	21,858	724
6/28	3,582	268	10,232	411
6/29	4,316	327	23,831	609
6/30	9,004	1,600	44,222	1,309
7/01	10,554	2,082	48,802	1,614
7/02	4,290	710	19,113	972
7/03	3,498	491	7,088	402
7/04	5,434	422	11,081	541
7/05	8,232	963	20,679	1,144
7/06	11,465	1,730	19,236	1,538
7/07	20,002	2,755	22,491	1,404
7/08	11,533	1,153	13,677	826
7/09	2,272	451	5,892	372
7/10	1,248	307	3,756	264
7/11	1,094	239	2,445	237
7/12	786	114	1,052	195
7/13	809	33	3,291	266
7/14	3,563	52	6,532	1,129
7/15	2,016	56	4,204	1,164
7/16	761	35	2,382	531
7/17	1,260	91	3,998	906
7/18	871	127	1,240	1,168
7/19	621	135	745	333
7/20	738	81	765	426
7/21	668	72	752	349

-continued-

Table 1.—Page 2 of 2

Date	Left Bank		Right Bank	
	Inshore	Offshore	Inshore	Offshore
7/22	773	26	834	291
7/23	761	53	1,045	485
7/24	1,420	74	2,704	700
7/25	2,133	142	8,311	1,880
7/26	2,293	164	13,845	1,349
7/27	1,343	132	9,469	1,911
7/28	1,616	220	10,320	1,013
7/29	3,058	327	14,862	730
7/30	5,395	272	26,737	1,081
7/31	11,458	520	22,874	1,001
8/01	16,761	221	42,369	764
8/02	11,472	66	29,001	1,045
8/03	6,601	83	45,373	873
8/04	5,525	67	20,778	973
8/05	3,958	87	21,268	926
8/06	4,392	85	17,900	938
8/07	32,313	229	43,772	1,571
8/08	34,195	202	16,782	1,709
8/09	25,048	189	10,109	1,533
8/10	25,938	113	5,807	1,107
8/11	27,243	222	6,382	1,067
8/12	18,627	525	6,265	839
8/13	29,726	431	3,774	1,515
8/14	29,219	425	8,832	1,378
8/15	9,062	132	4,247	1,173
8/16	3,118	117	4,213	440
Total	622,239	40,855	884,820	52,706

Table 2.—Drift gillnet catch by mesh size and salmon species, Nushagak River sonar project, 9 June–23 July, 2004.

Gillnet Mesh Size	Species	Drift Stratum			
		Left Bank		Right Bank	
		Inshore	Offshore	Inshore	Offshore
13.0-cm	Sockeye	117	23	208	69
	Chinook	26	184	9	99
	Chum	66	46	80	124
	Coho	0	0	2	1
	Pink	0	0	2	1
15.2-cm	Sockeye	156	21	210	66
	Chinook	33	215	26	122
	Chum	64	67	106	106
	Coho	1	0	0	0
	Pink	0	0	0	0
20.6-cm	Sockeye	32	3	71	12
	Chinook	25	147	11	57
	Chum	11	9	23	13
	Coho	0	0	1	0
	Pink	0	0	0	0
All Meshes	Sockeye	305	47	489	147
	Chinook	84	546	46	278
	Chum	141	122	209	243
	Coho	1	0	3	1
	Pink	0	0	2	1

Table 3.—Drift gillnet catch by mesh size and species, Nushagak River sonar project, 24 July–16 August 2004.

Gillnet Mesh Size	Species	Drift Stratum			
		Left Bank		Right Bank	
		Inshore	Offshore	Inshore	Offshore
11.4-cm	Sockeye	2	0	6	2
	Chinook	0	3	1	7
	Chum	3	4	11	9
	Coho	19	31	25	35
	Pink	78	47	158	53
13.0-cm	Sockeye	2	1	4	1
	Chinook	0	5	0	0
	Chum	3	5	9	9
	Coho	28	34	29	27
	Pink	73	26	95	33
15.2-cm	Sockeye	1	0	2	1
	Chinook	1	3	1	5
	Chum	1	1	13	5
	Coho	22	11	14	14
	Pink	18	18	31	30
All Meshes	Sockeye	5	1	12	4
	Chinook	1	11	2	12
	Chum	7	10	33	23
	Coho	69	76	68	76
	Pink	169	91	284	116

Table 4.—Left bank inshore stratum escapement sampling catch proportions by date, drift session, and salmon species, 2004.

Date	Session	Catch	Proportion of Catch				
			Sockeye	Chinook	Chum	Coho	Pink
6/9	3	1	0.00	1.00	0.00	0.00	0.00
6/12	1	1	0.00	1.00	0.00	0.00	0.00
6/12	3	1	0.00	1.00	0.00	0.00	0.00
6/13	1	2	0.00	1.00	0.00	0.00	0.00
6/13	3	3	0.00	1.00	0.00	0.00	0.00
6/16	3	2	0.50	0.50	0.00	0.00	0.00
6/17	1	9	0.00	0.33	0.67	0.00	0.00
6/17	3	5	0.60	0.20	0.20	0.00	0.00
6/18	1	4	0.75	0.25	0.00	0.00	0.00
6/18	3	5	0.80	0.20	0.00	0.00	0.00
6/19	1	2	0.50	0.00	0.50	0.00	0.00
6/19	2	6	0.17	0.83	0.00	0.00	0.00
6/19	3	30	0.20	0.37	0.43	0.00	0.00
6/20	1	25	0.08	0.32	0.60	0.00	0.00
6/20	2	7	0.71	0.00	0.29	0.00	0.00
6/20	3	21	0.71	0.00	0.29	0.00	0.00
6/21	1	12	0.50	0.08	0.42	0.00	0.00
6/21	2	8	0.63	0.13	0.25	0.00	0.00
6/21	3	8	0.38	0.00	0.63	0.00	0.00
6/22	1	5	1.00	0.00	0.00	0.00	0.00
6/22	2	11	0.09	0.09	0.82	0.00	0.00
6/22	3	4	0.25	0.50	0.25	0.00	0.00
6/23	1	3	0.67	0.33	0.00	0.00	0.00
6/23	2	4	0.25	0.50	0.25	0.00	0.00
6/23	3	19	0.21	0.21	0.58	0.00	0.00
6/24	1	20	0.25	0.60	0.15	0.00	0.00
6/24	2	8	0.88	0.00	0.13	0.00	0.00
6/24	3	11	0.73	0.00	0.27	0.00	0.00
6/25	1	9	1.00	0.00	0.00	0.00	0.00
6/25	2	8	0.75	0.25	0.00	0.00	0.00
6/25	3	6	0.67	0.00	0.33	0.00	0.00
6/26	1	9	0.67	0.00	0.33	0.00	0.00
6/26	2	8	0.88	0.00	0.13	0.00	0.00
6/26	3	3	1.00	0.00	0.00	0.00	0.00
6/27	1	5	0.60	0.20	0.20	0.00	0.00
6/27	2	2	0.00	0.00	1.00	0.00	0.00
6/27	3	5	0.00	0.00	1.00	0.00	0.00
6/28	1	4	0.50	0.25	0.25	0.00	0.00
6/28	2	2	1.00	0.00	0.00	0.00	0.00
6/29	1	3	1.00	0.00	0.00	0.00	0.00
6/29	2	15	1.00	0.00	0.00	0.00	0.00
6/29	3	8	0.88	0.00	0.13	0.00	0.00

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Table 5.—Page 4 of 4.

Date	Drift Session	Catch	Proportion of Catch				
			Sockeye	Chinook	Chum	Coho	Pink
8/03	3	1	0.00	0.00	0.00	0.00	1.00
8/04	3	3	0.00	0.00	0.00	0.00	1.00
8/06	1	2	0.00	0.00	0.00	0.00	1.00
8/06	3	2	0.00	0.00	0.50	0.00	0.50
8/07	1	2	0.00	0.00	0.00	0.00	1.00
8/09	3	13	0.00	0.08	0.00	0.23	0.69
8/08	1	6	0.00	0.00	0.17	0.00	0.83
8/08	3	8	0.00	0.00	0.00	0.63	0.38
8/09	1	2	0.00	0.00	0.00	0.00	1.00
8/10	1	5	0.00	0.00	0.00	0.20	0.80
8/10	3	7	0.00	0.14	0.00	0.57	0.29
8/11	1	7	0.00	0.00	0.00	0.14	0.86
8/11	3	2	0.00	0.00	0.00	0.50	0.50
8/12	3	5	0.00	0.00	0.00	0.20	0.80
8/13	1	13	0.00	0.00	0.00	0.54	0.46
8/13	3	11	0.00	0.00	0.00	0.91	0.09
8/14	1	9	0.00	0.00	0.00	0.89	0.11
8/14	3	14	0.00	0.00	0.00	0.79	0.21
8/15	1	7	0.00	0.00	0.00	1.00	0.00
8/15	3	8	0.00	0.00	0.00	1.00	0.00

Table 6.—Page 4 of 4.

Date	Drift Session	Catch	Proportion of Catch				
			Sockeye	Chinook	Chum	Coho	Pink
8/06	1	8	0.00	0.00	0.00	0.13	0.88
8/06	3	2	0.00	0.00	0.00	0.00	1.00
8/07	1	21	0.05	0.00	0.10	0.19	0.67
8/07	3	18	0.00	0.00	0.00	0.11	0.89
8/08	1	22	0.05	0.00	0.00	0.18	0.77
8/08	3	2	0.00	0.00	0.00	0.00	1.00
8/09	1	27	0.00	0.00	0.04	0.11	0.85
8/09	3	4	0.00	0.00	0.00	0.00	1.00
8/10	1	4	0.00	0.00	0.00	0.25	0.75
8/10	3	4	0.00	0.00	0.00	0.25	0.75
8/11	1	2	0.00	0.00	0.00	1.00	0.00
8/11	3	1	0.00	0.00	0.00	0.00	1.00
8/12	1	7	0.00	0.00	0.00	0.29	0.71
8/12	3	1	0.00	0.00	0.00	0.00	1.00
8/13	1	1	0.00	0.00	0.00	1.00	0.00
8/13	3	3	0.00	0.00	0.00	0.33	0.67
8/14	1	6	0.00	0.00	0.00	1.00	0.00
8/15	1	3	0.00	0.00	0.00	1.00	0.00
8/15	3	2	0.00	0.00	0.00	0.00	1.00

Table 7.—Right bank offshore stratum escapement sampling catch proportions by date, drift session, and salmon species, 2004.

Date	Session	Catch	Proportion of Catch				
			Sockeye	Chinook	Chum	Coho	Pink
6/12	1	1	0.00	1.00	0.00	0.00	0.00
6/12	3	11	0.00	0.73	0.27	0.00	0.00
6/13	3	10	0.00	0.90	0.10	0.00	0.00
6/14	3	2	0.00	1.00	0.00	0.00	0.00
6/15	1	2	1.00	0.00	0.00	0.00	0.00
6/15	3	2	0.00	0.50	0.50	0.00	0.00
6/16	3	3	0.00	0.67	0.33	0.00	0.00
6/17	1	8	0.00	0.75	0.25	0.00	0.00
6/17	3	8	0.00	0.75	0.25	0.00	0.00
6/18	1	5	0.00	0.80	0.20	0.00	0.00
6/18	2	5	0.00	0.00	1.00	0.00	0.00
6/18	3	5	0.00	0.60	0.40	0.00	0.00
6/19	1	2	0.00	0.00	1.00	0.00	0.00
6/19	2	18	0.00	0.44	0.56	0.00	0.00
6/19	3	14	0.07	0.36	0.57	0.00	0.00
6/20	1	3	0.00	0.67	0.33	0.00	0.00
6/20	2	9	0.00	0.67	0.33	0.00	0.00
6/20	3	19	0.21	0.37	0.42	0.00	0.00
6/21	1	6	0.00	0.83	0.17	0.00	0.00
6/21	2	8	0.13	0.25	0.63	0.00	0.00
6/21	3	17	0.06	0.35	0.59	0.00	0.00
6/22	1	4	0.00	0.25	0.75	0.00	0.00
6/22	2	9	0.00	0.56	0.44	0.00	0.00
6/22	3	11	0.00	0.27	0.73	0.00	0.00
6/23	1	5	0.20	0.60	0.20	0.00	0.00
6/23	2	6	0.00	0.83	0.17	0.00	0.00
6/23	3	15	0.00	0.67	0.33	0.00	0.00
6/24	1	12	0.00	0.58	0.42	0.00	0.00
6/24	2	9	0.11	0.44	0.44	0.00	0.00
6/24	3	19	0.16	0.79	0.05	0.00	0.00
6/25	1	8	0.63	0.13	0.25	0.00	0.00
6/25	2	18	0.33	0.22	0.44	0.00	0.00
6/25	3	12	0.25	0.42	0.33	0.00	0.00
6/26	1	8	0.63	0.25	0.13	0.00	0.00
6/26	2	16	0.13	0.50	0.38	0.00	0.00
6/26	3	16	0.06	0.56	0.38	0.00	0.00
6/27	1	3	0.33	0.33	0.33	0.00	0.00
6/27	2	5	0.20	0.40	0.40	0.00	0.00
6/27	3	9	0.00	0.11	0.89	0.00	0.00
6/28	1	1	0.00	0.00	1.00	0.00	0.00
6/28	2	6	0.00	0.83	0.17	0.00	0.00
6/28	3	6	0.00	0.17	0.83	0.00	0.00

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Table 7.—Page 2 of 4.

Date	Session	Catch	Proportion of Catch				
			Sockeye	Chinook	Chum	Coho	Pink
6/29	1	1	0.00	1.00	0.00	0.00	0.00
6/29	2	1	0.00	1.00	0.00	0.00	0.00
6/29	3	7	0.14	0.57	0.29	0.00	0.00
6/30	1	10	0.30	0.30	0.40	0.00	0.00
6/30	2	9	0.56	0.22	0.22	0.00	0.00
6/30	3	9	0.33	0.33	0.33	0.00	0.00
7/01	1	6	0.33	0.17	0.50	0.00	0.00
7/01	2	4	0.75	0.00	0.25	0.00	0.00
7/01	3	9	0.11	0.67	0.22	0.00	0.00
7/02	1	4	0.50	0.50	0.00	0.00	0.00
7/02	2	6	0.33	0.50	0.17	0.00	0.00
7/02	3	4	0.50	0.50	0.00	0.00	0.00
7/03	1	4	0.25	0.50	0.25	0.00	0.00
7/03	2	2	0.00	1.00	0.00	0.00	0.00
7/03	3	7	0.43	0.14	0.43	0.00	0.00
7/04	2	1	0.00	1.00	0.00	0.00	0.00
7/04	3	8	0.50	0.38	0.13	0.00	0.00
7/05	1	7	0.43	0.57	0.00	0.00	0.00
7/05	2	10	0.30	0.10	0.60	0.00	0.00
7/05	3	9	0.78	0.00	0.22	0.00	0.00
7/06	1	5	0.40	0.00	0.60	0.00	0.00
7/06	2	12	0.42	0.33	0.25	0.00	0.00
7/06	3	9	0.44	0.22	0.33	0.00	0.00
7/07	1	4	0.00	1.00	0.00	0.00	0.00
7/07	2	11	0.64	0.27	0.09	0.00	0.00
7/07	3	4	0.50	0.25	0.25	0.00	0.00
7/08	1	3	0.67	0.00	0.33	0.00	0.00
7/08	2	6	0.17	0.67	0.17	0.00	0.00
7/08	3	6	0.33	0.17	0.50	0.00	0.00
7/09	1	4	0.25	0.75	0.00	0.00	0.00
7/09	2	4	0.00	0.75	0.25	0.00	0.00
7/09	3	3	0.00	0.67	0.33	0.00	0.00
7/10	1	2	0.50	0.50	0.00	0.00	0.00
7/10	2	7	0.71	0.14	0.14	0.00	0.00
7/10	3	4	0.50	0.25	0.25	0.00	0.00
7/11	1	1	0.00	1.00	0.00	0.00	0.00
7/11	2	6	0.50	0.17	0.33	0.00	0.00
7/11	3	1	0.00	1.00	0.00	0.00	0.00
7/12	2	5	0.20	0.40	0.40	0.00	0.00
7/12	3	3	0.00	0.33	0.67	0.00	0.00
7/13	1	1	0.00	1.00	0.00	0.00	0.00
7/13	2	3	0.67	0.33	0.00	0.00	0.00

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Table 7.—Page 3 of 4.

Date	Drift Session	Catch	Proportion of Catch				
			Sockeye	Chinook	Chum	Coho	Pink
7/13	3	8	0.25	0.38	0.38	0.00	0.00
7/14	1	10	0.20	0.30	0.50	0.00	0.00
7/14	2	14	0.36	0.14	0.50	0.00	0.00
7/14	3	8	0.38	0.13	0.50	0.00	0.00
7/15	1	2	0.00	1.00	0.00	0.00	0.00
7/15	3	4	0.50	0.25	0.25	0.00	0.00
7/16	1	3	0.67	0.33	0.00	0.00	0.00
7/16	3	6	0.33	0.33	0.33	0.00	0.00
7/17	1	3	0.00	0.33	0.67	0.00	0.00
7/17	3	5	0.00	0.00	1.00	0.00	0.00
7/18	1	1	0.00	0.00	1.00	0.00	0.00
7/18	3	8	0.00	0.00	1.00	0.00	0.00
7/19	1	3	0.67	0.00	0.33	0.00	0.00
7/19	3	1	0.00	0.00	1.00	0.00	0.00
7/20	1	1	1.00	0.00	0.00	0.00	0.00
7/20	3	3	0.67	0.00	0.33	0.00	0.00
7/21	1	1	0.00	1.00	0.00	0.00	0.00
7/21	3	5	0.00	0.80	0.20	0.00	0.00
7/22	1	1	0.00	1.00	0.00	0.00	0.00
7/22	3	2	0.00	0.50	0.50	0.00	0.00
7/23	1	2	0.50	0.00	0.00	0.50	0.00
7/23	3	1	0.00	0.00	0.00	0.00	1.00
7/24	1	2	0.00	0.00	1.00	0.00	0.00
7/24	3	3	0.00	0.00	1.00	0.00	0.00
7/25	1	5	0.00	0.00	0.60	0.20	0.20
7/25	3	2	0.00	0.00	0.50	0.50	0.00
7/26	1	4	0.00	0.25	0.00	0.75	0.00
7/26	3	7	0.14	0.14	0.14	0.57	0.00
7/27	1	10	0.10	0.00	0.40	0.20	0.30
7/27	3	5	0.00	0.20	0.00	0.60	0.20
7/28	1	6	0.00	0.00	0.00	0.67	0.33
7/28	3	4	0.00	0.25	0.25	0.50	0.00
7/29	1	7	0.00	0.43	0.14	0.14	0.29
7/29	3	4	0.00	0.50	0.50	0.00	0.00
7/30	1	3	0.00	0.00	0.00	0.33	0.67
7/30	3	6	0.00	0.17	0.33	0.33	0.17
7/31	1	2	0.00	0.00	0.00	0.50	0.50
7/31	3	1	0.00	0.00	0.00	0.00	1.00
8/01	1	1	0.00	0.00	0.00	0.00	1.00
8/01	3	1	0.00	0.00	0.00	1.00	0.00
8/02	1	4	0.00	0.00	0.00	0.25	0.75
8/02	3	3	0.00	0.00	0.00	0.00	1.00

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Table 7.—Page 4 of 4.

Date	Drift Session	Catch	Proportion of Catch				
			Sockeye	Chinook	Chum	Coho	Pink
8/03	1	8	0.00	0.00	0.13	0.00	0.88
8/03	3	10	0.00	0.10	0.10	0.20	0.60
8/04	1	1	0.00	0.00	0.00	1.00	0.00
8/04	3	2	0.00	0.00	0.00	0.00	1.00
8/05	1	2	0.00	0.00	0.00	0.00	1.00
8/05	3	5	0.20	0.00	0.00	0.00	0.80
8/06	1	1	0.00	0.00	0.00	1.00	0.00
8/06	3	4	0.00	0.00	0.00	0.25	0.75
8/07	1	3	0.00	0.00	0.00	0.00	1.00
8/07	3	6	0.00	0.17	0.00	0.00	0.83
8/08	1	7	0.00	0.00	0.00	0.29	0.71
8/08	3	19	0.05	0.00	0.00	0.11	0.84
8/09	1	7	0.00	0.00	0.14	0.14	0.71
8/09	3	7	0.00	0.00	0.00	0.29	0.71
8/10	1	11	0.00	0.00	0.00	0.00	1.00
8/10	3	1	0.00	0.00	0.00	0.00	1.00
8/11	1	1	0.00	0.00	0.00	0.00	1.00
8/11	3	2	0.00	0.00	0.00	0.00	1.00
8/12	1	1	0.00	0.00	0.00	1.00	0.00
8/12	3	13	0.00	0.00	0.00	0.15	0.85
8/13	1	10	0.00	0.00	0.00	0.80	0.20
8/13	3	12	0.00	0.00	0.00	0.92	0.08
8/14	1	11	0.00	0.00	0.00	0.91	0.09
8/14	3	7	0.00	0.00	0.00	0.71	0.29
8/15	1	6	0.00	0.00	0.00	1.00	0.00
8/15	3	1	0.00	0.00	0.00	1.00	0.00

Table 8.—Final daily and cumulative escapement estimates by salmon species, Nushagak River sonar project, 2004.

Date	Sockeye		Chinook		Chum		Coho		Pink		Total	
	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
6/08	0	0	660	660	0	0	0	0	0	0	660	660
6/09	0	0	1,119	1,779	0	0	0	0	0	0	1,119	1,779
6/10	0	0	1,266	3,045	0	0	0	0	0	0	1,266	3,045
6/11	0	0	1,066	4,111	0	0	0	0	0	0	1,066	4,111
6/12	1,186	1,186	3,024	7,135	1,099	1,099	0	0	0	0	5,309	9,420
6/13	821	2,007	4,863	11,997	2,109	3,207	0	0	0	0	7,792	17,212
6/14	145	2,152	2,494	14,492	450	3,657	0	0	0	0	3,089	20,301
6/15	195	2,346	881	15,373	1,011	4,669	0	0	0	0	2,087	22,388
6/16	402	2,749	957	16,330	1,630	6,299	0	0	0	0	2,990	25,378
6/17	2,499	5,248	2,543	18,873	10,674	16,973	0	0	0	0	15,716	41,094
6/18	4,120	9,368	3,516	22,389	5,334	22,307	0	0	0	0	12,970	54,064
6/19	9,550	18,918	20,395	42,784	24,978	47,285	0	0	0	0	54,923	108,987
6/20	29,527	48,444	10,629	53,413	46,225	93,510	0	0	0	0	86,381	195,368
6/21	17,754	66,198	3,004	56,417	16,835	110,346	0	0	0	0	37,593	232,961
6/22	6,146	72,344	2,127	58,544	14,700	125,046	0	0	0	0	22,973	255,934
6/23	8,452	80,796	5,192	63,736	15,504	140,550	0	0	0	0	29,147	285,081
6/24	36,530	117,325	11,428	75,164	16,626	157,176	0	0	0	0	64,584	349,665
6/25	29,831	147,157	2,208	77,372	6,699	163,875	0	0	0	0	38,739	388,404
6/26	14,901	162,058	1,304	78,676	4,997	168,872	0	0	0	0	21,202	409,606
6/27	12,704	174,762	2,536	81,212	12,510	181,382	0	0	0	0	27,750	437,356
6/28	7,114	181,876	724	81,936	6,655	188,037	0	0	0	0	14,493	451,849
6/29	25,240	207,116	1,734	83,670	2,109	190,146	0	0	0	0	29,083	480,932
6/30	37,925	245,042	3,653	87,323	14,556	204,703	0	0	0	0	56,135	537,067
7/01	45,691	290,732	4,584	91,907	12,777	217,480	0	0	0	0	63,052	600,119
7/02	18,282	309,014	2,778	94,685	4,025	221,505	0	0	0	0	25,085	625,204
7/03	9,060	318,075	1,820	96,505	599	222,104	0	0	0	0	11,479	636,683
7/04	12,969	331,044	1,164	97,669	3,344	225,448	0	0	0	0	17,478	654,161
7/05	25,240	356,284	2,824	100,493	2,954	228,402	0	0	0	0	31,018	685,179
7/06	23,859	380,143	1,978	102,471	8,132	236,534	0	0	0	0	33,969	719,148
7/07	37,439	417,582	3,839	106,310	5,374	241,908	0	0	0	0	46,652	765,800

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Table 8.—Page 2 of 3.

Date	Sockeye		Chinook		Chum		Coho		Pink		Total	
	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
7/08	21,749	439,332	1,359	107,669	4,080	245,988	0	0	0	0	27,189	792,989
7/09	5,448	444,779	639	108,308	2,901	248,889	0	0	0	0	8,987	801,976
7/10	4,788	449,567	240	108,548	547	249,436	0	0	0	0	5,575	807,551
7/11	3,247	452,814	515	109,063	253	249,689	0	0	0	0	4,015	811,566
7/12	1,273	454,087	557	109,620	317	250,007	0	0	0	0	2,147	813,713
7/13	3,575	457,661	312	109,932	512	250,519	0	0	0	0	4,399	818,112
7/14	8,385	466,046	506	110,438	2,385	252,904	0	0	0	0	11,276	829,388
7/15	4,643	470,689	602	111,040	2,195	255,099	0	0	0	0	7,440	836,828
7/16	2,923	473,612	162	111,201	625	255,723	0	0	0	0	3,709	840,537
7/17	3,074	476,686	159	111,360	2,757	258,480	265	265	0	0	6,255	846,792
7/18	1,124	477,810	160	111,521	1,956	260,436	166	431	0	0	3,406	850,198
7/19	729	478,539	243	111,764	754	261,190	108	539	0	0	1,834	852,032
7/20	1,218	479,757	183	111,946	507	261,697	102	641	0	0	2,010	854,042
7/21	998	480,756	592	112,539	153	261,851	97	738	0	0	1,841	855,883
7/22	1,183	481,939	412	112,950	153	262,004	176	914	0	0	1,924	857,807
7/23	1,430	483,370	179	113,130	104	262,108	630	1,544	0	0	2,344	860,151
7/24	1,188	484,558	284	113,414	2,824	264,932	579	2,123	22	22	4,898	865,049
7/25	0	484,558	57	113,471	3,547	268,479	4,382	6,505	4,480	4,502	12,466	877,515
7/26	0	484,558	0	113,471	2,253	270,732	13,926	20,432	1,472	5,974	17,651	895,166
7/27	0	484,558	174	113,645	262	270,994	2,294	22,726	10,125	16,098	12,855	908,021
7/28	879	485,437	26	113,671	1,902	272,896	5,479	28,206	4,882	20,980	13,169	921,190
7/29	809	486,246	659	114,330	1,904	274,800	1,890	30,096	13,715	34,696	18,977	940,167
7/30	0	486,246	1,809	116,139	0	274,800	888	30,984	30,787	65,483	33,485	973,652
7/31	78	486,324	0	116,139	78	274,878	2,291	33,275	33,406	98,889	35,853	1,009,505
8/01	3,036	489,360	0	116,139	740	275,618	1,756	35,031	54,583	153,472	60,115	1,069,620
8/02	1,391	490,752	8	116,146	3,264	278,882	661	35,692	36,260	189,732	41,584	1,111,204
8/03	0	490,752	8	116,154	78	278,960	1,727	37,419	51,117	240,849	52,930	1,164,134
8/04	0	490,752	5	116,159	84	279,045	1,366	38,784	25,888	266,737	27,343	1,191,477
8/05	32	490,784	6	116,165	1,624	280,669	1,503	40,287	23,074	289,811	26,239	1,217,716
8/06	91	490,875	0	116,165	8	280,677	935	41,222	22,282	312,093	23,315	1,241,031

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Table 8.—Page 3 of 3.

Date	Sockeye		Chinook		Chum		Coho		Pink		Total	
	Daily	Cum.	Daily	Cum.								
8/07	0	490,875	198	116,363	2,970	283,647	6,071	47,293	68,645	380,738	77,885	1,318,916
8/08	856	491,730	0	116,363	14	283,661	7,214	54,507	44,805	425,543	52,888	1,371,804
8/09	0	491,730	14	116,377	150	283,811	3,618	58,125	33,096	458,639	36,879	1,408,683
8/10	0	491,730	23	116,400	0	283,811	7,597	65,722	25,346	483,985	32,965	1,441,648
8/11	0	491,730	0	116,400	0	283,811	10,368	76,090	24,546	508,530	34,914	1,476,562
8/12	0	491,730	0	116,400	0	283,811	1,066	77,156	25,191	533,721	26,256	1,502,818
8/13	0	491,730	0	116,400	0	283,811	23,140	100,296	12,306	546,027	35,446	1,538,264
8/14	0	491,730	0	116,400	0	283,811	39,240	139,536	614	546,640	39,854	1,578,118
8/15	0	491,730	0	116,400	0	283,811	8,537	148,073	6,077	552,718	14,614	1,592,732
8/16	0	491,730	0	116,400	0	283,811	4,540	152,613	3,348	556,066	7,888	1,600,620
Total	491,730		116,400		283,811		152,613		556,066		1,600,620	

Table 9.—Sockeye salmon escapement estimates and average escapement percentage by date, Nushagak River, 1990–2004.

Date	Year													Average Percent ^a				
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Daily	Cum.	
06/04				0												0.0	0.0	
06/05		74		0												0.0	0.0	
06/06	11	126		0												0.0	0.0	
06/07	11	94		0												65	0.0	0.0
06/08	32	80		0		36								0	290	0	0.0	0.0
06/09	145	74	0	0	5	96	110	395	222	5				0	443	0	0.0	0.0
06/10	33	114	0	0	6	140	199	440	553	8	73			0	376	0	0.0	0.1
06/11	23	79	0	0	7	64	117	319	261	19	46			0	280	0	0.0	0.1
06/12	15	87	0	0	5	68	142	278	165	17	67	230	0	0	1,186	0.0	0.1	
06/13	52	75	0	0	4	104	153	516	127	20	245	173	221	0	821	0.0	0.1	
06/14	37	71	0	0	12	202	165	521	108	14	86	3,253	0	0	145	0.1	0.2	
06/15	149	866	0	125	10	995	172	589	115	29	54	3,819	0	98	195	0.1	0.3	
06/16	117	2,360	0	1,902	442	606	79	1,384	128	268	261	1,031	47	106	402	0.1	0.4	
06/17	51	836	0	3,260	951	522	239	1,300	60	221	386	247	3	3,541	2,499	0.2	0.6	
06/18	43	770	0	1,119	1,239	729	3,639	910	152	110	140	194	269	7,598	4,120	0.3	0.9	
06/19	47	443	915	491	2,661	798	901	1,866	330	45	453	819	1,530	4,119	9,550	0.3	1.2	
06/20	0	677	1,132	456	1,218	437	1,078	1,962	6,384	32	724	5,772	8,598	3,443	29,527	0.8	2.0	
06/21	0	860	1,811	300	647	377	3,912	1,001	3,190	35	405	8,768	6,099	9,853	17,754	0.7	2.7	
06/22	995	1,457	1,594	224	1,830	301	5,798	2,631	3,751	33	264	14,214	6,998	41,818	6,146	1.1	3.9	
06/23	5,297	3,088	951	16,939	1,415	443	8,927	2,645	2,625	43	124	34,970	6,149	78,962	8,452	2.2	6.1	
06/24	1,960	10,144	999	66,906	2,703	1,430	9,896	3,759	3,976	2,405	94	29,123	8,488	41,316	36,530	2.9	8.9	
06/25	1,009	11,286	1,379	24,187	2,625	9,495	18,041	7,204	8,092	2,431	1,968	38,804	4,840	52,701	29,831	2.8	11.7	
06/26	320	10,463	20,836	20,082	2,768	24,849	22,147	16,643	6,141	666	16,742	44,456	4,097	42,533	14,901	3.2	15.0	
06/27	355	8,926	35,478	71,399	3,354	36,906	16,513	16,883	6,956	539	4,247	28,083	15,018	27,905	12,704	3.7	18.7	
06/28	1,540	11,075	32,522	82,675	2,779	9,701	21,166	8,316	7,854	3,309	45,905	10,449	32,821	34,842	7,114	4.1	22.7	
06/29	1,935	29,203	14,576	36,278	1,976	8,465	9,786	10,127	7,793	2,233	70,221	6,527	20,799	18,552	25,240	3.4	26.2	
06/30	1,604	15,961	18,597	50,751	2,089	12,221	14,900	13,695	10,455	4,014	46,978	22,989	42,265	14,068	37,925	4.0	30.2	
07/01	9,858	62,496	12,759	37,845	3,143	16,971	19,093	25,312	6,262	9,217	30,858	50,353	14,095	19,014	45,691	4.7	34.9	
07/02	85,624	30,292	5,701	21,457	12,185	8,510	21,304	24,776	10,675	42,891	13,997	39,027	16,136	18,946	18,282	4.8	39.8	
07/03	55,341	88,577	3,239	76,757	41,736	10,376	40,175	13,902	37,050	44,770	13,110	85,925	4,484	49,433	9,060	7.5	47.2	

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Table 9.—Page 2 of 3.

Date	Year													Average Percent ^a			
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Daily	Cum.
07/04	23,207	100,822	19,927	66,723	51,759	7,911	27,231	17,175	52,668	33,122	15,431	127,463	6,760	42,629	12,969	7.9	55.1
07/05	8,977	35,766	22,121	44,078	23,759	3,097	29,537	6,006	116,872	35,790	6,656	60,521	5,315	14,427	25,240	5.7	60.8
07/06	34,852	4,094	63,871	25,266	22,208	6,548	19,431	14,090	72,184	29,267	4,479	32,314	7,548	6,225	23,859	4.8	65.6
07/07	314,041	2,228	71,122	14,559	22,030	12,049	24,920	14,301	20,985	24,132	2,530	30,063	9,636	3,706	37,439	7.9	73.5
07/08	56,812	1,641	36,090	12,452	18,918	48,281	17,535	12,874	25,902	9,572	2,535	11,410	10,991	6,045	21,749	3.8	77.3
07/09	10,124	1,306	12,242	6,289	30,097	24,353	14,260	14,221	12,095	6,973	3,630	15,791	22,223	3,974	5,448	2.4	79.7
07/10	4,864	1,809	9,580	4,837	128,121	5,606	11,098	12,039	4,647	5,081	5,121	17,238	14,826	2,357	4,788	3.0	82.7
07/11	2,752	3,342	89,913	2,764	22,288	8,590	9,794	6,161	7,003	5,816	2,581	8,273	9,110	6,919	3,247	2.5	85.2
07/12	7,528	4,810	173,110	2,678	11,051	3,930	11,307	20,575	3,664	4,873	5,086	6,604	5,593	3,375	1,273	3.5	88.6
07/13	6,579	2,073	17,703	2,725	8,748	1,780	14,442	26,312	1,317	2,011	41,229	4,814	4,584	6,364	3,575	1.9	90.5
07/14	3,799	2,984	8,591	3,239	6,121	1,231	10,546	15,542	1,114	2,914	27,279	6,326	4,029	3,522	8,385	1.4	91.9
07/15	3,165	2,185	4,679	2,161	2,858	1,088	7,112	9,620	834	5,174	4,694	7,171	3,955	3,501	4,643	0.8	92.7
07/16	2,129	3,716	3,525	2,436	3,451	1,453	7,542	4,630	898	3,622	4,880	8,297	3,631	2,505	2,923	0.7	93.4
07/17	1,953	6,206	2,895	3,824	14,088	1,230	3,874	9,264	435	2,784	3,903	5,340	4,255	1,078	3,074	0.8	94.3
07/18	1,319	7,250	1,559	1,891	11,342	656	14,891	6,472	275	3,367	3,771	7,388	464	1,214	1,124	0.8	95.1
07/19	845	7,552	1,417	1,803	5,247	632	18,421	4,085	309	2,449	2,562	7,647	658	1,499	729	0.7	95.8
07/20	883	3,914	1,433	908	4,015	607	7,282	2,419	577	2,437	2,157	4,081	1,016	891	1,218	0.4	96.3
07/21	1,206	2,408	2,016	776	3,419	443	3,877	2,515	758	2,770	2,294	3,126	1,383		998	0.4	96.6
07/22	2,785	3,854	825	554	2,741	753	7,491	2,303	1,143	3,193	1,812	6,315	1,097		1,183	0.5	97.1
07/23	3,579	2,516		501	3,081	522	7,905	4,245	412	2,540	1,986	979	845		1,430	0.4	97.5
07/24	3,278	575		455	2,797	869	7,182	3,084	260	2,033	2,332	784	714		1,188	0.3	97.8
07/25	483	16		363	6,579	1,579	534	1,861	289	1,574	1,421	165	1,183		0	0.2	98.0
07/26	572	15		44	6,159	1,201	485	1,895	616	1,933	238	179	334		0	0.2	98.2
07/27	600	16		35	6,420	197	861	1,157	429	1,183	291	144	0		0	0.1	98.4
07/28	788	62		23	2,058	360	348	1,340	855	864	1,202	83	0		879	0.1	98.5
07/29	1,204	224		27	2,440	56	454	1,126	829	343	1,027	34	0		809	0.1	98.6
07/30	1,220	102		28	186	70	1,024	4	536	260	827	51	1,842		0	0.1	98.7
07/31	763	33		21	286	53	259	6	631	270	183	201	331		78	0.0	98.7
08/01	130	32		45	226	34	317	5	866	187	1,035	236	278		3,036	0.1	98.8
08/02	138	61		35	112	62	868	4	911	34	1,071	63	123		1,391	0.1	98.9

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Date	Year													Average Percent ^a			
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Daily	Cum.
08/03	735	25		18	77	46	38	10	730	26	1,031	51	0		0	0.0	98.9
08/04	188	21		33	71	30	695	8	2,009	212	769	35	0		0	0.1	98.9
08/05	1,175	13		45	121	315	1,317	4	774	328	9	34	0		32	0.1	99.0
08/06	2,993	26		23	83	253	720	5	1,052	170		26	0		91	0.1	99.1
08/07	1,788	13		181	106	78	386	5	558	70		25	0		0	0.0	99.1
08/08	5,030	7		82	99	29	197	6	8	42		29	0		856	0.1	99.2
08/09	867	9		24	40	31	223	9	4	22		190	0		0	0.0	99.2
08/10	0	14		0	180	43	232	25		30		104	0		0	0.0	99.2
08/11	0	17		0	121	70	139	30		147		94	0		0		
08/12	0	22		0	0	33	83	20		99		104	0		0		
08/13	236	18		0	0	114	18	19		30		217	0		0		
08/14	177	24		0	0	54	16	20		21		135	0		0		
08/15	0	25		0	0	23	3	9		30		43	0		0		
08/16	0	8		0	0	25	7	4		22		28	0		0		
08/17	0	3		0	0	20	8	6		15		16	0				
08/18	0	5		0	0	36	17	4		23		17					
08/19	0	2		0	3	24	12	5		48		46					
08/20	0	3		0	2	0	9	7		222		16					
08/21	0	1		0	2	0	1	10		206							
08/22	0			0	3	0	5	33		74							
08/23	0			0	2	0	5	14		56							
08/24	0			0	1	0	2	7		49							
08/25	0			0	0	0	3	9		15							
08/26	0						15	5									
08/27	0						18	3									
08/28	0						2	5									
08/29								4									
08/30									6								
08/31									24								
09/01									14								
Total	684,348	496,504	699,092	719,085	513,314	285,297	507,643	377,029	462,870	315,897	407,500	807,539	319,685	584,540	495,738		

^a Average percent of total annual escapement 4 June through 10 August 1990–2003.

Table 10.—Page 3 of 3.

Date	Year													Average Percent ^a			
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Daily	Cum.
08/03	0	31		17	9	20	36	0	1,365	25	323	57	324			8	
08/04	0	23		25	10	10	16	0	1,289	80	156	36	290			5	
08/05	0	18		33	0	96	28	0	297	84	0	42	504			6	
08/06	0	28		13	0	103	21	0	386	23		39	0			0	
08/07	0	12		101	0	43	18	0	276	8		30	13			198	
08/08	0	8		48	0	12	10	0	91	5		45	122			0	
08/09	0	11		17	0	14	16	0	48	4		260	103			14	
08/10	0	27		0	0	17	19	0	2	7		117	60			23	
08/11	0	28		0	0	25	3	0	1	15		94	0			0	
08/12	0	28		0	0	9	2	0	2	7		435	0			0	
08/13	0	14		0	0	29	1	0	2	8		293	0			0	
08/14	0	9		0	0	15	1	0	1	6		133	0			0	
08/15	0	8		0	0	6	0	0	1	3		52	0			0	
08/16	0	16		0	0	7	0	0	4	6		31	0			0	
08/17	0	7		0	0	7	0	0	17	4		30	0			0	
08/18	0	7		0	0	11	0	0	8	5		29					
08/19	0	3		0	0	7	0	0	2	4		42					
08/20	0	4		0	0	0	0	0	1	4		41					
08/21	0	1		0	0	0	0	0	1	3							
08/22	0			0	0	0	0	0	0	0		4					
08/23	0			0	0	0	0	0	0	0		6					
08/24	0			0	0	0	0	0	0	0		4					
08/25	0			0	0	0	0	0	0	0		1					
Total	67,935	108,333	86,832	97,812	95,954	85,622	52,127	40,705	117,495	66,329	60,372	96,277	91,145	84,034	120,408		

^a Average percent of total annual escapement 4 June through 31 July 1990–2004.

Table 11.—Page 2 of 3.

Date	Year														Average Percent ^a		
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Daily	Cum.
07/04	6,148	57,022	3,530	19,039	11,018	4,351	5,053	1,249	21,653	16,369	2,445	28,512	4,164	7,008	3,344	4.5	70.2
07/05	2,364	17,481	3,769	6,358	16,547	1,910	1,256	413	24,007	25,340	948	26,953	6,631	9,967	2,954	3.4	73.7
07/06	19,729	1,546	6,620	4,392	8,063	3,392	1,759	1,084	21,323	11,083	693	14,630	3,718	6,898	8,132	2.6	76.3
07/07	19,224	936	13,819	2,819	7,176	7,703	1,674	642	18,917	8,004	430	14,176	5,104	18,579	5,374	2.9	79.2
07/08	28,154	739	5,901	2,712	5,729	18,750	2,366	201	23,583	3,437	415	12,882	3,715	12,354	4,080	2.9	82.1
07/09	6,448	559	3,023	4,578	14,793	5,325	1,909	1,336	11,201	2,541	524	18,939	2,048	4,379	2,901	1.9	84.0
07/10	10,333	780	2,362	3,690	22,801	2,097	1,430	665	5,645	2,244	677	19,411	5,257	6,592	547	2.0	86.0
07/11	3,337	1,366	19,174	2,098	6,060	2,989	855	308	8,801	2,437	314	9,898	2,752	5,067	253	1.5	87.5
07/12	2,854	1,706	14,505	1,612	3,270	1,639	898	1,207	4,537	2,084	627	7,687	3,561	4,982	317	1.2	88.7
07/13	2,472	1,580	6,202	1,600	2,667	819	1,068	3,580	1,588	969	3,505	5,841	5,112	4,570	512	1.0	89.7
07/14	1,035	2,223	3,027	2,696	2,369	507	803	2,042	1,165	1,247	3,875	8,119	9,838	3,045	2,385	1.0	90.7
07/15	564	1,646	1,603	1,995	1,117	449	654	1,204	647	1,892	687	9,892	4,468	3,309	2,195	0.8	91.5
07/16	436	2,752	1,351	2,263	1,340	638	669	611	597	1,483	705	11,582	3,365	3,142	625	0.7	92.2
07/17	612	4,559	1,225	3,409	5,197	523	242	1,321	343	1,157	626	8,079	5,868	3,834	2,757	0.9	93.2
07/18	496	5,325	614	1,719	2,675	283	817	748	209	1,609	616	10,033	4,859	2,870	1,956	0.8	94.0
07/19	651	5,615	550	1,644	900	282	1,072	376	228	1,181	449	9,551	1,566	4,392	754	0.7	94.7
07/20	702	2,938	548	878	750	253	490	228	415	1,270	359	5,057	1,203	3,628	507	0.4	95.1
07/21	1,011	1,876	755	720	606	204	286	230	590	1,483	374	3,850	4,260		153	0.4	95.5
07/22	2,313	3,217	290	494	679	365	334	179	870	1,270	283	7,193	2,986		153	0.5	96.0
07/23	2,872	1,973		475	769	245	352	330	302	1,039	301	4,995	1,566		104	0.4	96.3
07/24	2,703	471		433	688	384	325	291	171	1,010	343	3,779	1,203		2,824	0.3	96.7
07/25	2,641	67		359	1,652	428	240	140	169	730	221	1,181	4,260		3,547	0.4	97.0
07/26	2,495	68		13	1,759	337	227	156	343	1,011	79	1,242	2,986		2,253	0.3	97.3
07/27	2,265	73		15	1,828	35	440	76	245	579	95	1,008	1,937		262	0.2	97.6
07/28	4,130	256		13	642	68	263	95	436	454	403	597	636		1,902	0.2	97.8
07/29	601	978		8	114	27	350	90	418	200	359	245	1,098		1,904	0.1	97.9
07/30	525	376		9	173	35	633		272	145	269	349	969		0	0.1	98.0
07/31	318	153		10	196	26	199		313	154	177	1,440	2,546		78	0.1	98.2
08/01	447	161		29	218	10	35		377	110	336	1,608	1,870		740	0.1	98.3
08/02	46	334		10	102	23	398		438	26	353	442	1,133		3,264	0.2	98.4

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Table 11.—Page 3 of 3.

Date	Year													Average Percent ^a			
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Daily	Cum.
08/03	269	149		11	44	11	170		1,099	24	328	347	1,523		78	0.1	98.5
08/04	557	123		12	40	16	126		1,398	114	433	246	15		84	0.1	98.6
08/05	828	79		15	38	197	285		257	152	89	249	78		1,624	0.1	98.7
08/06	3,290	159		10	40	133	126		343	59	16	199	43		8	0.1	98.8
08/07	1,863	92		126	123	36	67		212	23	12	201			2,970	0.1	98.9
08/08	5,102	48		60	53	8	40		39	15	9	244			14	0.1	99.1
08/09	896	61		16	2	8	47		20	10	6	1,494			150	0.1	99.1
08/10	0	70			13	27	50			13	8	858			0	0.0	99.2
08/11	0	82			473	46	19			46	6	738			0		
08/12	0	122			33	26	10			28	7	1,209			0		
08/13	297	114			16	62	1			16	12	2,032			0		
08/14	199	166			17	23	1			10	8	1,139			0		
08/15	47	177			14	11				9	5	399			0		
08/16	16	32			10	9				8	5	253			0		
08/17	97	13			11	8				6	6	186					
08/18	97	25			8	6				9		182					
08/19	68	12			21	9				16		388					
08/20		13			17					51		266					
08/21		4			26					47							
08/22					25					19							
08/23					16					17							
08/24					12					13							
08/25					1					4							
Total	333,773	291,263	306,842	217,230	378,928	212,612	225,029	61,456	299,215	246,310	145,324	551,997	433,982	299,419	287,819		

^a Average percent of total annual escapement 4 June through 10 August 1990–2004.

Table 12.—Coho salmon escapement estimates and average escapement percentage by date, Nushagak River, 1990–2004.

Date	Year												Average Percent ^a		
	1990	1991	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2004	Daily	Cum.
06/29	0	25	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
06/30	0	17	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
07/01	0	43	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
07/02	0	29	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
07/03	0	24	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
07/04	0	63	0	0	0	0	0	0	0	17	0	0	0	0.0	0.0
07/05	0	39	0	0	0	0	0	0	0	38	0	0	0	0.0	0.0
07/06	0	12	0	0	0	0	0	0	0	25	0	0	0	0.0	0.0
07/07	0	8	0	0	0	80	0	0	0	18	0	0	0	0.0	0.0
07/08	0	9	0	0	347	135	0	0	0	15	0	0	0	0.0	0.1
07/09	0	5	0	0	0	128	0	0	0	37	0	0	0	0.0	0.1
07/10	0	3	0	426	378	157	0	0	10	35	0	0	0	0.1	0.2
07/11	0	5	0	125	585	558	0	0	10	24	0	0	0	0.1	0.3
07/12	0	6	0	112	244	419	42	0	291	27	0	0	0	0.1	0.4
07/13	0	175	0	96	99	387	52	867	101	72	0	0	0	0.2	0.5
07/14	0	265	0	155	67	271	420	1,088	138	2,187	0	0	0	0.4	0.9
07/15	0	193	0	81	57	292	269	1,009	209	324	110	0	0	0.2	1.1
07/16	0	329	0	103	77	208	159	789	165	353	484	0	0	0.2	1.4
07/17	0	556	0	142	64	176	317	527	118	794	382	0	265	0.3	1.7
07/18	0	642	0	566	35	553	282	323	171	813	730	0	166	0.4	2.0
07/19	25	651	0	546	31	1,016	212	361	128	674	614	0	108	0.4	2.4
07/20	30	333	0	458	31	440	117	568	141	612	489	0	102	0.3	2.7
07/21	51	193	0	358	22	318	125	908	169	592	306	861	97	0.3	3.0
07/22	114	246	0	465	35	890	115	1,373	120	883	416	808	176	0.5	3.5
07/23	127	196	0	539	22	735	210	468	109	1,111	6,723	816	630	1.0	4.5
07/24	131	43	0	493	49	1,004	150	281	120	756	4,553	627	579	0.7	5.2
07/25	432	591	0	1,212	1,715	2,589	87	244	88	1,351	2,780	1,158	4,382	1.4	6.6
07/26	494	620	1,427	1,843	1,225	2,885	96	588	659	1,417	2,763	1,189	13,926	2.5	9.1
07/27	508	645	1,127	1,970	554	7,481	49	447	561	1,782	2,235	6,174	2,294	2.2	11.2
07/28	701	2,199	752	1,996	581	20,959	72	780	452	7,414	1,364	6,508	5,479	4.2	15.4

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Table 12.—Page 2 of 3.

Date	Year												Average Percent ^a		
	1990	1991	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2004	Daily	Cum.
07/29	960	8,518	902	973	1,377	21,802	58	891	326	6,900	630	6,049	1,890	4.3	19.7
07/30	991	3,858	1,006	466	1,750	39,448	818	575	373	6,099	774	3,564	888	5.1	24.8
07/31	621	1,402	527	1,235	1,311	12,642	869	662	814	5,223	3,369	249	2,291	2.6	27.5
08/01	2,574	1,392	864	2,874	652	4,614	673	1,069	3,108	28,732	3,432	787	1,756	4.4	31.9
08/02	3,238	2,883	982	1,143	1,332	8,608	769	975	679	32,757	966	963	661	4.7	36.6
08/03	1,033	1,316	611	906	832	2,311	1,100	15,823	697	27,150	760	260	1,727	4.6	41.2
08/04	3,068	1,066	1,163	813	716	8,379	1,844	22,747	3,626	19,085	549	255	1,366	5.5	46.7
08/05	2,701	710	1,578	2,246	8,274	12,147	955	4,455	4,945	10,097	615	522	1,503	4.3	51.0
08/06	7,695	1,369	712	2,009	6,208	9,410	683	4,831	2,176	3,509	526	1,545	935	3.5	54.5
08/07	8,062	783	4,160	2,707	1,791	5,739	645	4,340	866	1,611	518	997	6,071	3.2	57.7
08/08	11,915	423	1,941	2,405	559	2,609	752	2,316	534	1,786	670	946	7,214	2.9	60.6
08/09	2,513	530	660	1,635	546	2,812	943	1,940	310	1,459	3,890	996	3,618	1.8	62.4
08/10	8,305	683	661	9,751	1,132	3,100	3,185	1,531	423	1,026	2,190	1,436	7,597	3.5	65.9
08/11	10,354	774	364	28,753	1,892	1,818	3,192	1,298	1,773	782	1,799	515	10,368	5.4	71.3
08/12	8,011	1,078	696	1,922	999	1,116	6,408	1,602	1,141	694	4,973	425	1,066	2.5	73.8
08/13	21,355	949	811	920	2,766	992	3,067	1,610	487	955	7,795	1,054	23,140	5.6	79.4
08/14	13,331	1,327	846	884	1,159	971	2,100	1,537	317	1,312	3,929	1,469	39,240	5.8	85.2
08/15	5,943	1,409	1,480	706	523	1,060	1,220	1,352	354	713	1,323	693	8,537	2.1	87.3
08/16	2,382	322	1,687	590	509	1,179	528	3,083	318	1,035	817	660	4,540	1.5	88.8
08/17	6,794	141	1,049	584	443	632	1,030	9,326	207	553	691	817		1.9	90.7
08/18	7,238	230	813	446	559	895	709	4,032	318		638			1.3	92.0
08/19	3,450	110	9,074	1,065	499	906	1,029	1,936	592		1,048			1.7	93.7
08/20	2,063	124	4,151	1,012	434	517	1,061	1,605	2,326		2,513			1.3	95.0
08/21	1,301	37	1,129	1,422	581	256	1,422	1,368	2,151					0.8	95.8
08/22	1,078		693	1,492	521	321	2,460	781	823					0.7	96.5
08/23	864		415	708	1,468	294	1,402	1,362	677					0.6	97.1
08/24	694		342	582	1,058	348	895	798	560					0.4	97.6
08/25	557		119	84	231	421	778	482	172					0.2	97.8
08/26	808					1,339	587								
08/27	2,801					643	755								

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Table 12.—Page 3 of 3.

Date	Year												Average Percent ^a		
	1990	1991	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2004	Daily	Cum.
08/28	2,130					335	632								
08/29	1,662						500								
08/30	1,458						763								
08/31	848						1,170								
09/01	722						967								
09/02	484						649								
09/03	602						800								
09/04	1,011						781								
09/05	831						704								
09/06	1,064						734								
09/07	1,283						754								
09/08	984						795								
09/09	1,289						705								
09/10	1,373						678								
09/11	1,512						659								
09/12	287						608								
09/13							486								
Total	166,833	43,581	46,728	86,007	50,330	193,337	61,090	108,944	38,851	176,849	72,366	46,347	156,621		

^a Average percentage of total annual escapement 29 June through 25 August, 1990–91, 1993–2002, and 2004.

Table 13.—Pink salmon escapement estimates and average escapement percentage by date, Nushagak River, 1980–2004.

Date	Year												Average Percent ^a	
	1980	1982	1984	1986	1988	1990	1994	1996	1998	2000	2002	2004	Daily	Cum.
07/01	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
07/02	0	0	549	0	0	0	0	0	0	0	0	0	0.0	0.0
07/03	0	0	0	0	0	0	121	0	0	0	0	0	0.0	0.0
07/04	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
07/05	0	0	0	0	0	0	258	0	0	0	0	0	0.0	0.0
07/06	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
07/07	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
07/08	0	0	0	0	0	0	0	0	0	0	0	0	0.0	0.0
07/09	0	0	0	0	227	0	672	58	0	42	0	0	0.0	0.0
07/10	0	0	0	0	134	0	2,340	270	0	52	0	0	0.0	0.1
07/11	0	0	251	0	191	0	335	273	0	33	0	0	0.0	0.1
07/12	0	0	794	0	0	0	268	341	0	30	0	0	0.0	0.1
07/13	0	0	266	0	0	0	256	475	1,032	53	0	0	0.0	0.1
07/14	0	3,216	165	215	304	179	262	329	2,019	70	0	0	0.1	0.2
07/15	0	3,216	126	0	107	72	151	187	2,062	33	0	0	0.1	0.3
07/16	0	3,216	146	1,809	113	63	172	198	1,882	44	0	0	0.1	0.4
07/17	0	3,216	348	0	275	112	194	453	1,080	461	0	0	0.1	0.5
07/18	1,855	12,864	6,386	0	331	97	168	1,765	676	492	0	0	0.3	0.8
07/19	216	9,648	7,859	0	140	106	562	2,698	772	470	0	0	0.3	1.1
07/20	1,600	12,864	18,126	356	279	110	570	796	1,264	424	632	0	0.5	1.6
07/21	2,300	19,297	31,880	255	451	151	365	613	1,875	390	4,584	0	0.8	2.5
07/22	2,996	19,297	24,188	202	432	348	1,095	2,451	2,852	517	1,634	0	0.8	3.2
07/23	5,510	35,377	23,845	4,330	4,209	447	1,206	2,255	1,008	804	2,877	0	1.1	4.3
07/24	2,161	16,081	70,605	4,363	6,170	410	1,059	2,318	644	466	7,512	22	1.5	5.8
07/25	3,100	61,106	64,968	2,384	8,514	665	2,432	32,951	630	1,066	11,140	4,480	2.6	8.5
07/26	4,999	25,729	54,894	625	14,669	676	3,288	29,860	1,524	1,565	10,929	1,472	2.0	10.5
07/27	10,475	196,182	66,214	1,239	13,728	647	3,507	52,386	1,125	1,964	39,397	10,125	5.4	15.9
07/28	21,782	93,267	41,567	6,853	9,722	1,053	14,964	65,581	2,137	8,009	35,342	4,882	4.1	20.0
07/29	22,057	109,347	89,976	7,728	7,873	17,893	6,889	80,657	2,354	7,018	48,302	13,715	5.6	25.6
07/30	32,754	109,347	134,987	8,620	17,365	17,770	32,461	165,951	1,515	6,018	18,472	30,787	7.8	33.4

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Date	Year												Average Percent ^a			
	1980	1982	1984	1986	1988	1990	1994	1996	1998	2000	2002	2004	Daily	Cum.		
07/31	18,992	147,941	119,383	4,297	38,549	11,070	16,177	82,605	1,774	12,026	7,425	33,406	6.7	40.1		
08/01	115,186	173,669	137,574	4,828	23,238	32,017	32,832	39,307	2,878	18,467	13,626	54,583	8.8	48.8		
08/02	61,476	118,996	158,472	7,738	32,460	39,470	16,842	56,063	2,627	20,656	21,617	36,260	7.7	56.6		
08/03	120,802	67,538	104,080	6,589	55,663	64,515	2,644	57,074	31,210	17,769	32,527	51,117	8.3	64.8		
08/04	75,708	54,674	97,528	3,878	60,774	86,613	2,380	24,795	25,074	13,169	21,146	25,888	6.7	71.5		
08/05	26,757	38,593	79,075	1,883	19,695	193,407	6,886	28,660	7,768	9,588	10,110	23,074	6.0	77.5		
08/06	21,750	9,648	96,630	1,064	17,049	90,081	6,417	29,066	8,977	3,307	14,445	22,282	4.3	81.9		
08/07		3,216	113,159	386	23,977	76,456	9,052	18,574	7,269	1,428	3,615	68,645	4.4	86.3		
08/08		9,648	83,438	326	80,869	88,089	7,751	7,806	2,679	1,715	3,922	44,805	4.5	90.7		
08/09		12,864	61,145	284	17,246	38,446	2,138	8,100	2,190	1,336	2,381	33,096	2.4	93.2		
08/10		35,377	46,597	507	6,451	9,279	6,980	9,098	1,490	803	2,425	25,346	2.0	95.1		
08/11		19,297	73,178	1,100	6,699	11,861	5,131	5,097	1,306	647	1,372	24,546	2.0	97.2		
08/12			26,831	66	9,763	9,429	360	2,993	1,592	591	838	25,191	1.1	98.2		
08/13			25,252	51	3,195	2,350	162	1,861	813	707	263	12,306	0.6	98.8		
08/14			9,403	124	3,491	1,257	150	1,827	640	1,096	445	614	0.3	99.1		
08/15				11,026	43	1,957	555	100	681	499	525	252	6,077	0.3	99.4	
08/16					3,498	24	1,636	178	106	737	691	687	184	3,348	0.2	99.5
08/17					3,308	20	2,762	405	95	383	2,183	393	245		0.1	99.7
08/18						1,702	1,432	580	85	530	1,007					
08/19							706	232	360	555	456					
08/20							438	442	258	309	484					
08/21							718	353	441	155	551					
08/22							392	297	453	175	466					
08/23							216	1,137	251	163	735					
08/24								587	114	213	379					
08/25									12	251	213					
08/26									802		804					
08/27										289		358				
08/28										148		206				
08/29											119					
08/30																
08/31																
Total	554,456	1,426,713	1,906,878	74,173	496,598	803,715	193,766	823,308	134,400	136,931	319,663	558,070				

^a Average percent of total annual escapement 1 July through 17 August, 1980–2004.

Table 14.—Age composition of sockeye salmon escapement, Nushagak River, 2004.

Sampling Period	Date		Age Group									Total
	Start	End	0.2	0.3	1.2	0.4	1.3	2.2	1.4	2.3	1.5	
Period 1:	08-Jun	02-Jul										
Percent (%)			1.9	2.1	11.2	0.2	67.5	1.0	13.3	2.6	0.2	100.0
SE (%)			0.7	0.7	1.5		2.3	0.5	1.7	0.8		2.0
Number of Fish			5,872	6,606	34,498	734	208,456	2,936	41,104	8,074	734	309,014
SE (Number)			2,059	2,181	4,748		7,065	1,463	5,120	2,405		10,752
Sample Size			8	9	47	1	284	4	56	11	1	421
Period 2:	03-Jul	16-Aug										
Percent (%)			1.6	4.7	29.2		53.8	0.9	8.8	0.9		100.0
SE (%)			0.7	1.2	2.6		2.8	0.5	1.6	0.5		2.5
Number of Fish			2,873	8,619	53,436		98,253	1,724	16,088	1,724		182,716
SE (Number)			1,277	2,176	4,668		5,117	992	2,908	992		8,047
Sample Size			5	15	93		171	3	28	3		318
Total												
Percent (%)			1.8	3.1	17.9	0.1	62.4	0.9	11.6	2.0	0.1	100.0
SE (%)			0.7	1.0	2.2		2.5	0.5	1.6	0.7		2.2
Number of Fish			8,745	15,225	87,934	734	306,709	4,660	57,192	9,798	734	491,730
SE (Number)			2,422	3,081	6,659		8,723	1,767	5,889	2,602		13,430
Sample Size			13	24	140	1	455	7	84	14	1	739

Table 15.—Sex composition by age and mean length (mm) by age, and sex of sockeye salmon escapement, Nushagak River, 2004.

Sampling Period	Date		Age Group									Total
	Start	End	0.2	0.3	1.2	0.4	1.3	2.2	1.4	2.3	1.5	
Period 1:	08-Jun	02-Jul										
Percent (Males)			75.0	44.4	74.5	100.0	59.9	75.0	44.6	36.4		58.9
Number of Males			4,404	2,936	25,690	734	124,780	2,202	18,350	2,936		182,032
Standard Error (Males)			1,787	1,463	4,163		7,398	1,268	3,564	1,463		9,687
Sample Size (Males)			6	4	35	1	170	3	25	4		248
Mean Length (Males)			459	525	463	610	582	490	612	564		563
Standard Error (Length-Males)			25.9	47.3	9.9		2.8	28.5	9.9	35.7		2.8
Sample Size (Length-Males)			6	4	35	1	170	3	25	4		248
Percent (Females)			25.0	55.6	25.5		40.1	25.0	55.4	63.6	100.0	41.1
Number of Females			1,468	3,670	8,808		83,676	734	22,754	5,138	734	126,982
Standard Error (Females)			1,037	1,633	2,509		6,700	734	3,938	1,928		8,643
Sample Size (Females)			2	5	12		114	1	31	7	1	173
Mean Length (Females)			423	540	492		556	461	578	547	593	553
Standard Error (Length-Females)			4	11	14		3		5	12		2
Sample Size (Length-Females)			2	5	12		113	1	31	7	1	172
Number (Not Identified)												
Sample Size (Not Identified)												
Number of Fish			5,872	6,606	34,498	734	208,456	2,936	41,104	8,074	734	309,014
Standard Error (Number)			2,066	2,193	4,861		9,981	1,465	5,311	2,420		12,982
Sample Size (Number)			8	9	47	1	284	4	56	11	1	421
Mean Length (Both)			450	533	470	610	572	483	593	553	593	559
Standard Error (Length-Both)			19.0	20.1	8.1		2.0	20.1	5.1	14.0		1.9
Sample Size (Length-Both)			8	9	47	1	284	4	56	11	1	421
Period 2:	03-Jul	16-Aug										
Percent (Males)			100.0	40.0	49.5		57.3	33.3	53.6	100.0		54.7
Number of Males			2,873	3,447	26,431		56,309	575	8,619	1,724		99,977
Standard Error (Males)					1,396	3,610		4,739	575	2,176		6,519
Sample Size (Males)			5	6	46		98	1	15	3		174
Mean Length (Males)			452	576	478		589	580	619	582		558
Standard Error (Length-Males)			40.3	15.0	9.4		4.3		15.6	22.3		3.9
Sample Size (Length-Males)			5	6	46		98	1	15	3		174
Percent (Females)					60.0	50.5		42.7	66.7	46.4		45.3
Number of Females			5,171	27,005			41,944	1,149	7,470			82,739
Standard Error (Females)			1,702	3,642			4,316	811	2,032			6,291
Sample Size (Females)			9	47			73	2	13			144
Mean Length (Females)			555	482			555	477	646			538
Standard Error (Length-Females)			9	5			3	3	33			4
Sample Size (Length-Females)			9	47			73	2	13			144
Number (Not Identified)												
Sample Size (Not Identified)												
Number of Fish			2,873	8,619	53,436		98,253	1,724	16,088	1,724		182,716
Standard Error (Number)					2,201	5,128		6,409	994	2,977		9,059
Sample Size (Number)			5	15	93		171	3	28	3		318
Mean Length (Both)			452	563	480		574	511	632	582		549
Standard Error (Length-Both)			40.3	7.8	5.3		2.8	1.6	17.3	22.3		2.7
Sample Size (Length-Both)			5	15	93		171	3	28	3		318

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Table 15.—Page 2 of 2.

Sampling Period	Date		Age Group									
	Start	End	0.2	0.3	1.2	0.4	1.3	2.2	1.4	2.3	1.5	Total
Total	08-Jun	16-Aug										
Percent (Males)			83.2	41.9	59.3	100.0	59.0	59.6	47.2	47.6		57.4
Number of Males			7,277	6,383	52,121	734	181,089	2,777	26,969	4,660		282,009
Standard Error (Males)			1,787	2,022	5,510		8,786	1,392	4,175	1,463		11,677
Sample Size (Males)			11	10	81	1	268	4	40	7		422
Mean Length (Males)			456	553	470	610	584	508	614	571		561
Standard Error (Length-Males)			21.5	20.3	6.7		2.4	20.7	8.3	21.5		2.3
Sample Size (Length-Males)			11	10	81	1	268	4	40	7		422
Percent (Females)			16.8	58.1	40.7		41.0	40.4	52.8	52.4	100.0	42.6
Number of Females			1,468	8,841	35,813		125,620	1,883	30,224	5,138	734	209,721
Standard Error (Females)			1,037	2,359	4,423		7,970	1,094	4,431	1,928		10,690
Sample Size (Females)			2	14	59		187	3	44	7	1	317
Mean Length (Females)			423	549	484		555	471	595	547	593	547
Standard Error (Length-Females)			4	7	5		2	2	9	12		2
Sample Size (Length-Females)			2	14	59		186	3	44	7	1	316
Number (Not Identified)												
Sample Size (Not Identified)												
Number of Fish			8,745	15,225	87,934	734	306,709	4,660	57,192	9,798	734	491,730
Standard Error (Number)			2,066	3,107	7,066		11,862	1,771	6,089	2,420		15,831
Sample Size (Number)			13	24	140	1	455	7	84	14	1	739
Mean Length (Both)			450	550	476	610	572	493	604	558	593	555
Standard Error (Length-Both)			17.9	9.1	4.4		1.6	11.3	6.3	11.8		1.6
Sample Size (Length-Both)			13	24	140	1	455	7	84	14	1	739

Table 16.—Age composition of Chinook salmon escapement, Nushagak River, 2004.

Sampling Period	Date		Age Group				Total
	Start	End	1.2	1.3	1.4	1.5	
Period 1:	08-Jun	16-Aug					
Percent (%)			24.2	42.5	32.4	0.9	100.0
SE (%)			1.8	2.1	2.0	0.4	2.0
Number of Fish			28,141	49,459	37,734	1,066	116,400
SE (Number)			2,135	2,465	2,334	475	4,038
Sample Size			132	232	177	5	546

Table 17.—Sex composition by age and mean length (mm) by age, and sex of Chinook salmon escapement, Nushagak River, 2004.

Sampling Period	Date		Age Group				Total
	Start	End	1.2	1.3	1.4	1.5	
Period 1:	08-Jun	16-Aug					
Percent (Males)			88.5	66.2	43.2	20.0	63.7
Number of Males			24,918	32,759	16,294	213	74,185
Standard Error (Males)			2,046	2,244	1,733	213	3,504
Sample Size (Males)			116	153	76	1	346
Mean Length (Males)			586	726	853	815	707
Standard Error (Length-Males)			6.0	6.4	11.0		4.2
Sample Size (Length-Males)			116	153	76	1	346
Percent (Females)			11.5	33.8	56.8	80.0	36.3
Number of Females			3,222	16,701	21,440	853	42,215
Standard Error (Females)			821	1,751	1,936	425	2,769
Sample Size (Females)			15	78	100	4	197
Mean Length (Females)			641	766	843	900	798
Standard Error (Length-Females)			23	8	9	17	6
Sample Size (Length-Females)			15	78	98	4	195
Number (Not Identified)							
Sample Size (Not Identified)			1	1	1		3
Number of Fish			28,141	49,459	37,734	1,066	116,400
Standard Error (Number)			2,205	2,847	2,598	476	4,466
Sample Size (Number)			132	232	177	5	546
Mean Length (Both)			592	740	848	883	740
Standard Error (Length-Both)			5.9	5.1	6.8	12.8	3.4
Sample Size (Length-Both)			131	231	176	5	543

Table 18.—Age composition of chum salmon escapement, Nushagak River, 2004.

Sampling Period	Date		Age Group				Total
	Start	End	0.2	0.3	0.4	0.5	
<i>Period 1:</i>	08-Jun	16-Aug					
Percent (%)			3.4	39.7	56.7	0.2	100.0
SE (%)			0.8	2.1	2.2		2.1
Number of Fish			9,694	112,555	161,024	539	283,811
SE (Number)			2,248	6,054	6,131		8,904
Sample Size			18	209	299	1	527

Table 19.—Sex composition by age and mean length (mm) by age and sex of chum salmon escapement, Nushagak River, 2004.

Sampling Period	Date		Age Group				Total
	Start	End	0.2	0.3	0.4	0.5	
<i>Period 1:</i>	08-Jun	16-Aug					
Percent (Males)			38.9	61.5	64.4		62.3
Number of Males			3,770	69,265	103,747		176,781
Standard Error (Males)			1,417	5,322	5,965		8,119
Sample Size (Males)			7	128	192		327
Mean Length (Males)			576	601	619		611
Standard Error (Length-Males)			11.3	2.7	2.6		1.9
Sample Size (Length-Males)			7	128	192		327
Percent (Females)			61.1	38.5	35.6	100.0	37.7
Number of Females			5,924	43,290	57,277	539	107,030
Standard Error (Females)			1,769	4,457	4,973		6,909
Sample Size (Females)			11	80	106	1	198
Mean Length (Females)			542	576	585	615	579
Standard Error (Length-Females)			11	5	4		3
Sample Size (Length-Females)			11	80	105	1	197
Number (Not Identified)							
Sample Size (Not Identified)				1	1		2
Number of Fish			9,694	112,555	161,024	539	283,811
Standard Error (Number)			2,266	6,942	7,766		10,660
Sample Size (Number)			18	209	299	1	527
Mean Length (Both)			555	591	607	615	599
Standard Error (Length-Both)			7.9	2.6	2.3		1.7
Sample Size (Length-Both)			18	208	298	1	525

Table 20.—Age composition of coho salmon escapement, Nushagak River, 2004.

Sampling Period	Date		Age Group			Total
	Start	End	1.1	2.1	3.1	
<i>Period 1:</i>	<i>17-Jul</i>	<i>16-Aug</i>				
Percent (%)			9.6	88.1	2.3	100.0
SE (%)			2.0	2.2	1.0	2.2
Number of Fish			14,634	134,495	3,484	152,613
SE (Number)			3,043	3,343	1,544	4,777
Sample Size			21	193	5	219

Table 21.—Sex composition by age and mean length (mm) by age and sex of coho salmon escapement, Nushagak River, 2004.

Sampling Period	Date		Age Group			Total
	Start	End	1.1	2.1	3.1	
<i>Period 1:</i>	<i>17-Jul</i>	<i>16-Aug</i>				
Percent (Males)			57.1	58.9	60.0	58.7
Number of Males			8,362	79,156	2,091	89,609
Standard Error (Males)			2,352	5,176	1,201	5,811
Sample Size (Males)			12	113	3	128
Mean Length (Males)			486	544	593	539
Standard Error (Length-Males)			12.1	4.3	19.8	4.0
Sample Size (Length-Males)			12	113	3	128
Percent (Females)			42.9	41.1	40.0	41.3
Number of Females			6,272	55,339	1,394	63,004
Standard Error (Females)			2,052	4,981	983	5,476
Sample Size (Females)			9	79	2	90
Mean Length (Females)			483	557	583	550
Standard Error (Length-Females)			21	4	32	4
Sample Size (Length-Females)			9	79	2	90
Number (Not Identified)				1		1
Sample Size (Not Identified)				1		1
Number of Fish			14,634	134,495	3,484	152,613
Standard Error (Number)			3,121	7,184	1,553	7,985
Sample Size (Number)			21	193	5	219
Mean Length (Both)			485	549	589	544
Standard Error (Length-Both)			11.1	3.0	14.8	2.9
Sample Size (Length-Both)			21	192	5	218

Table 22.—Average air and water temperature, Nushagak River sonar project, June, July and August, 2004.

Year	Average Air Temperature (°C)			Average Water Temperature (°C)		
	June	July	August	June	July	August
1986	11.4	12.7	11.0	14.3	12.5	10.0
1987	10.5	14.2	13.1	9.5	12.1	13.1
1988	12.5	14.7	12.6	11.1	14.8	13.7
1989	11.5	14.0	14.8	10.4	14.9	15.6
1990	12.1	13.7	12.3	11.7	14.8	14.1
1991	12.1	14.1	13.1	11.6	14.7	14.3
1992	12.3	12.8	^a	10.7	11.7	^a
1993	11.7	14.0	11.9	12.5	15.4	14.3
1994	11.3	11.8	11.7	12.8	12.8	14.6
1995	12.3	13.3	11.0	10.5	14.5	13.0
1996	11.2	12.8	11.5	12.0	14.3	13.2
1997	13.6	15.0	12.5	14.3	16.6	14.6
1998	10.7	12.9	11.4	9.1	13.2	13.2
1999	11.6	14.1	11.3	11.1	13.6	13.1
2000	11.9	12.7	13.0	11.2	13.7	13.3
2001	11.0	10.8	12.1	11.2	13.7	13.3
2002	13.0	13.3	14.6	11.7	14.2	15.8
2003	11.4	13.5	^a	13.0	14.2	^a
2004	13.3	15.5	16.7	12.7	15.9	16.3
1986-03 Min	10.5	10.8	11.0	9.1	11.7	10.0
1986-03 Max	13.6	15.0	14.8	14.3	16.6	15.8
1986-03 Average	11.8	13.4	12.4	11.6	14.0	13.7

^a Project not operated in August.

Table 23.—Genetic samples collected by date and species, Nushagak River sonar project, 2004.

Date	Species	Location	Samples
6/21 - 6/18	sockeye salmon	Nushagak Sonar - Set A	3
6/19 - 6/25	sockeye salmon	Nushagak Sonar - Set B	145
6/26 - 7/2	sockeye salmon	Nushagak Sonar - Set C	215
7/3 - 7/10	sockeye salmon	Nushagak Sonar - Set D	201
7/10 - 7/18	sockeye salmon	Nushagak Sonar - Set E	125
Total			689



Figure 1.—Nushagak River sonar site, Bristol Bay.

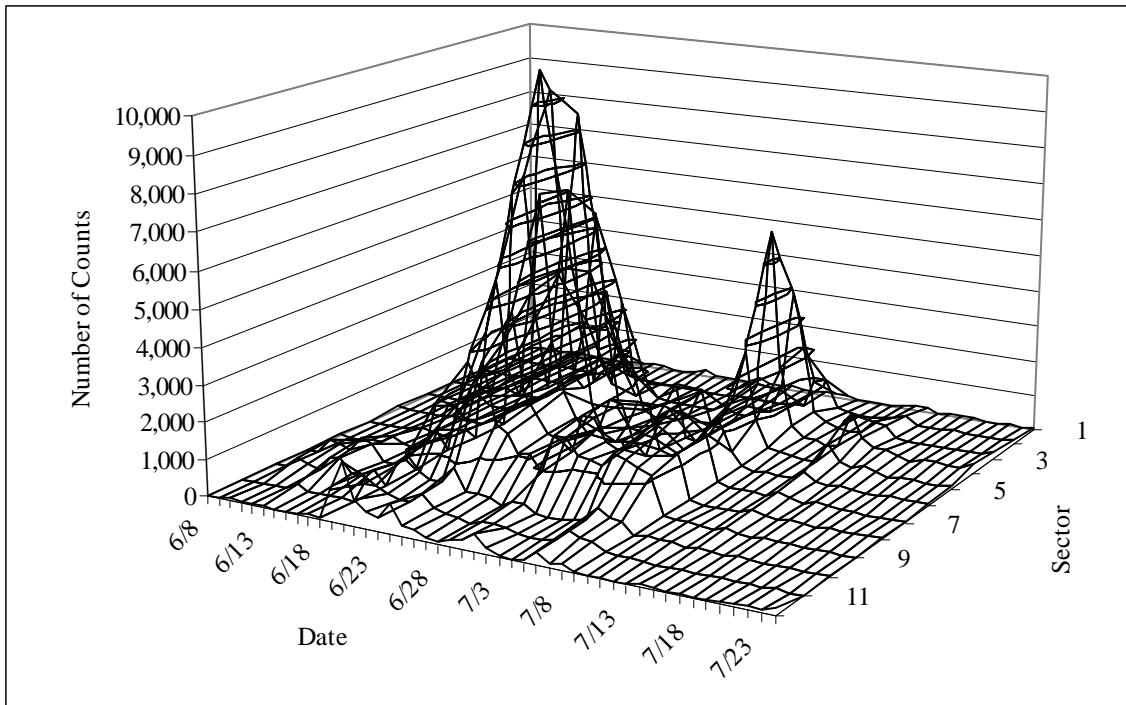


Figure 2.—Sonar counts by day and sector, left bank inshore, Nushagak River sonar project, 8 June–24 July, 2004.

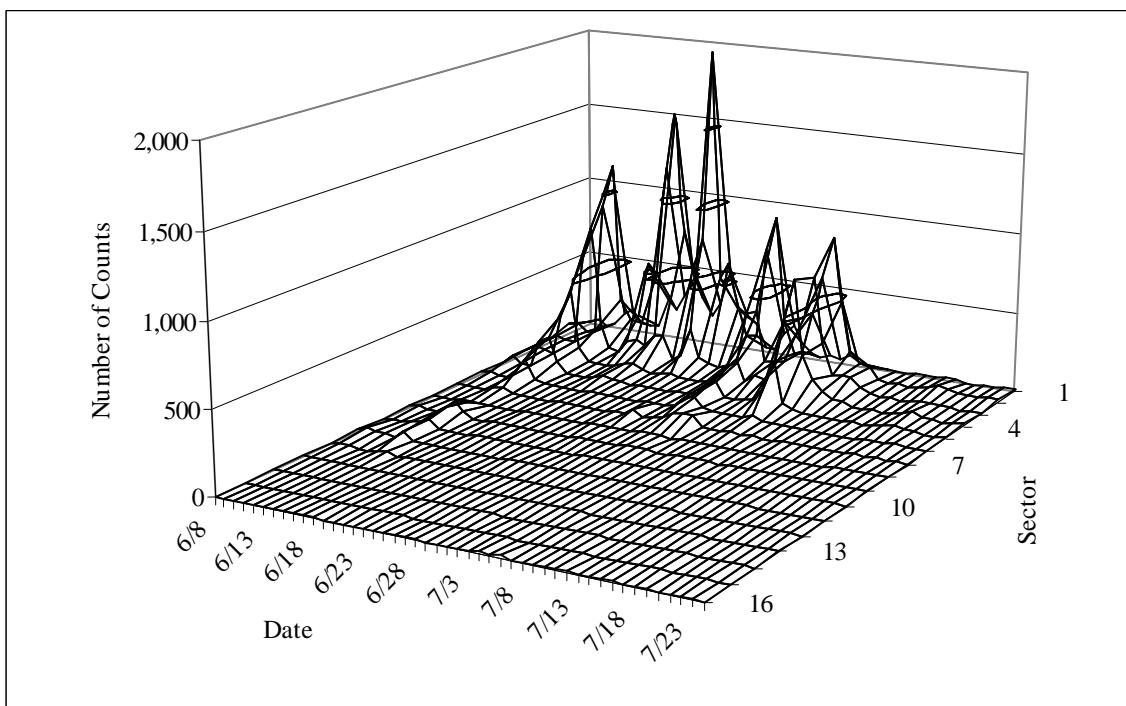


Figure 3.—Sonar counts by day and sector, left bank offshore, Nushagak River sonar project, 8 June–24 July, 2004.

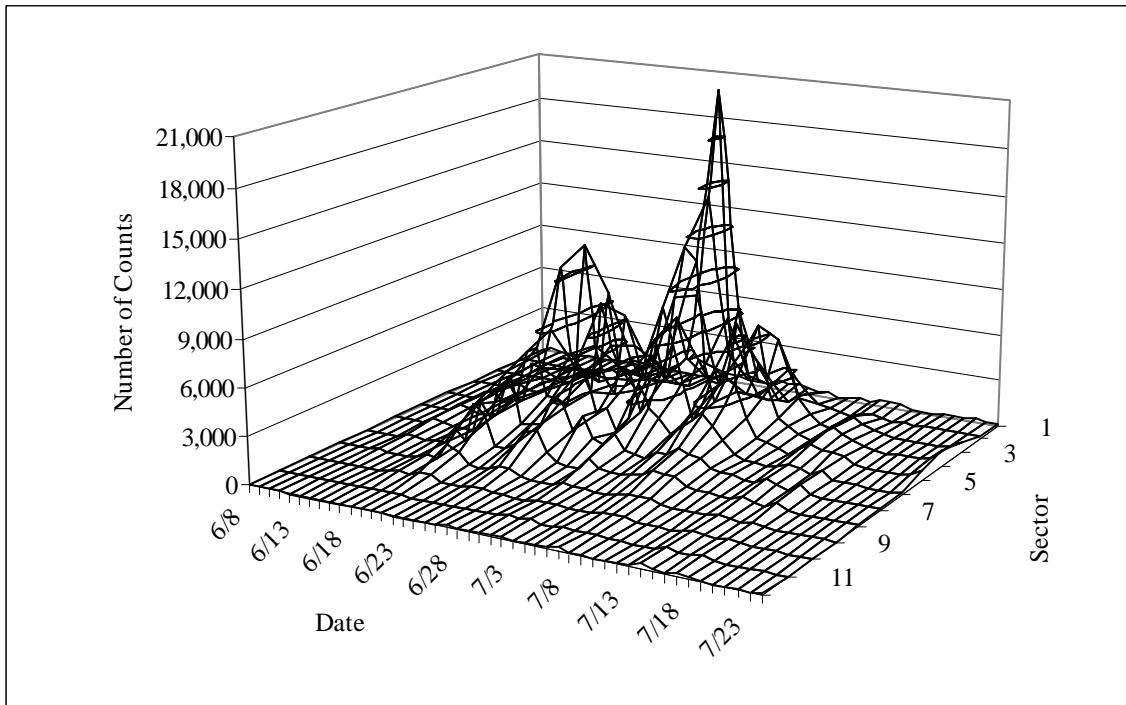


Figure 4.—Sonar counts by day and sector, right bank inshore, Nushagak River sonar project, 8 June–24 July, 2004.

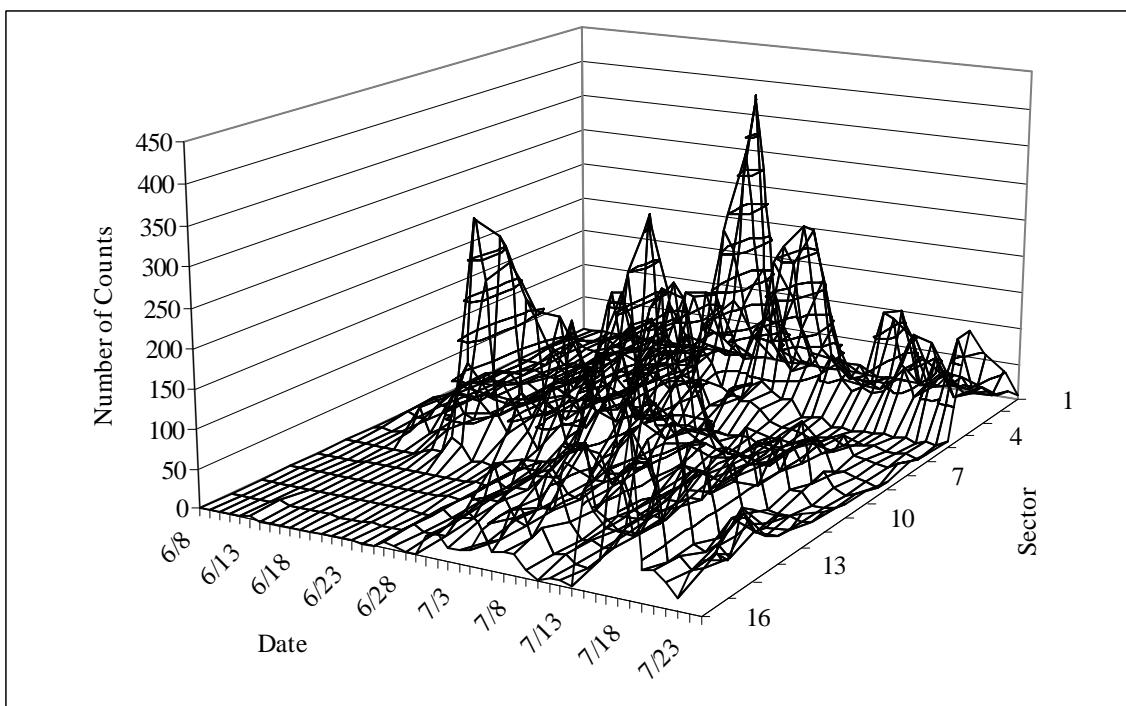


Figure 5.—Sonar counts by day and sector, right bank offshore, Nushagak River sonar project, 8 June–24 July 2004.

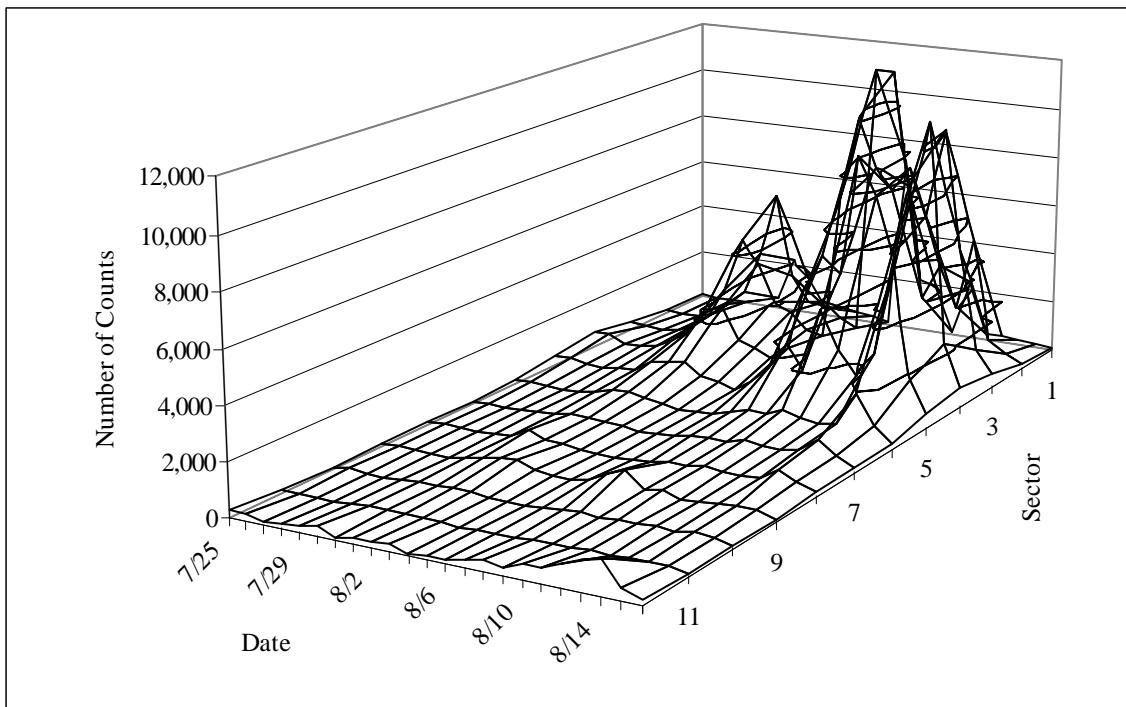


Figure 6.—Sonar counts by day and sector, left bank inshore, Nushagak River sonar project, 25 July–16 August, 2004.

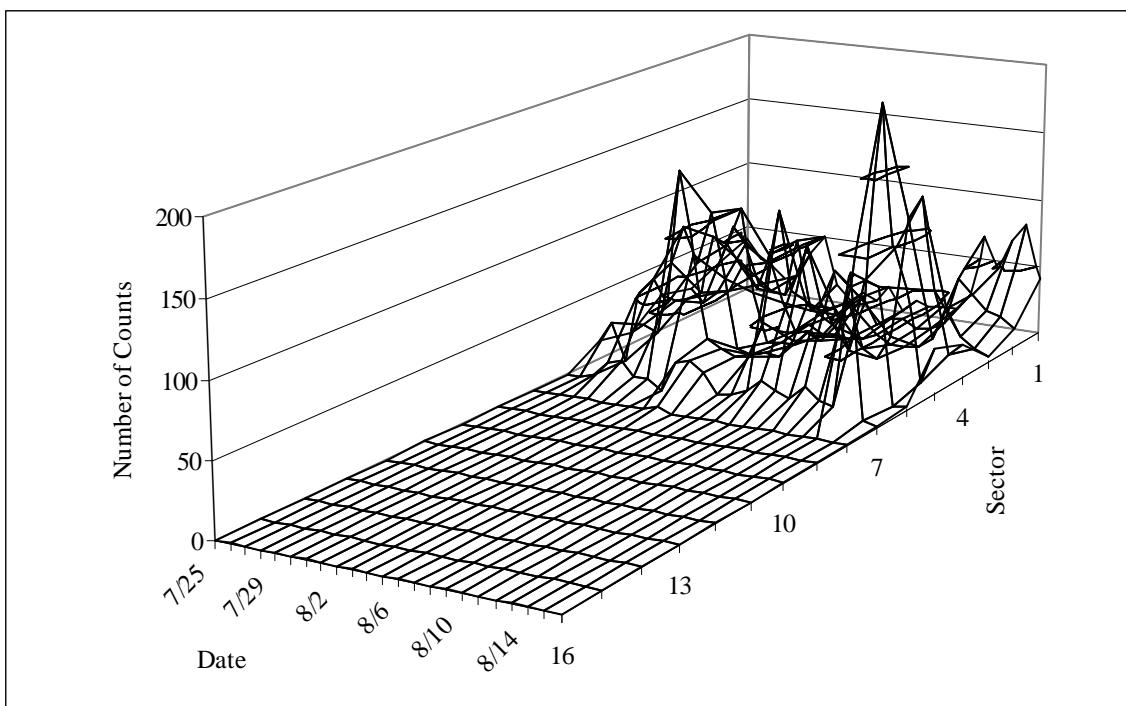


Figure 7.—Sonar counts by day and sector, left bank offshore, Nushagak River sonar project, 25 July–16 August, 2004.

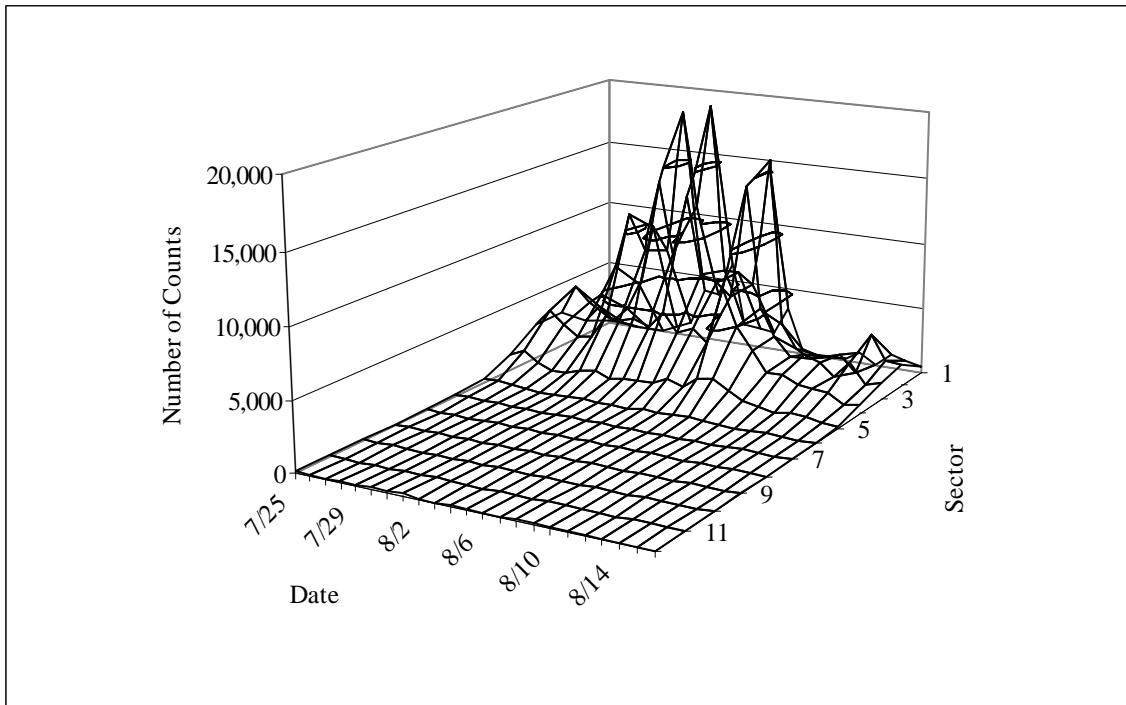


Figure 8.—Sonar counts by day and sector, right bank inshore, Nushagak River sonar project, 25 July–16 August, 2004.

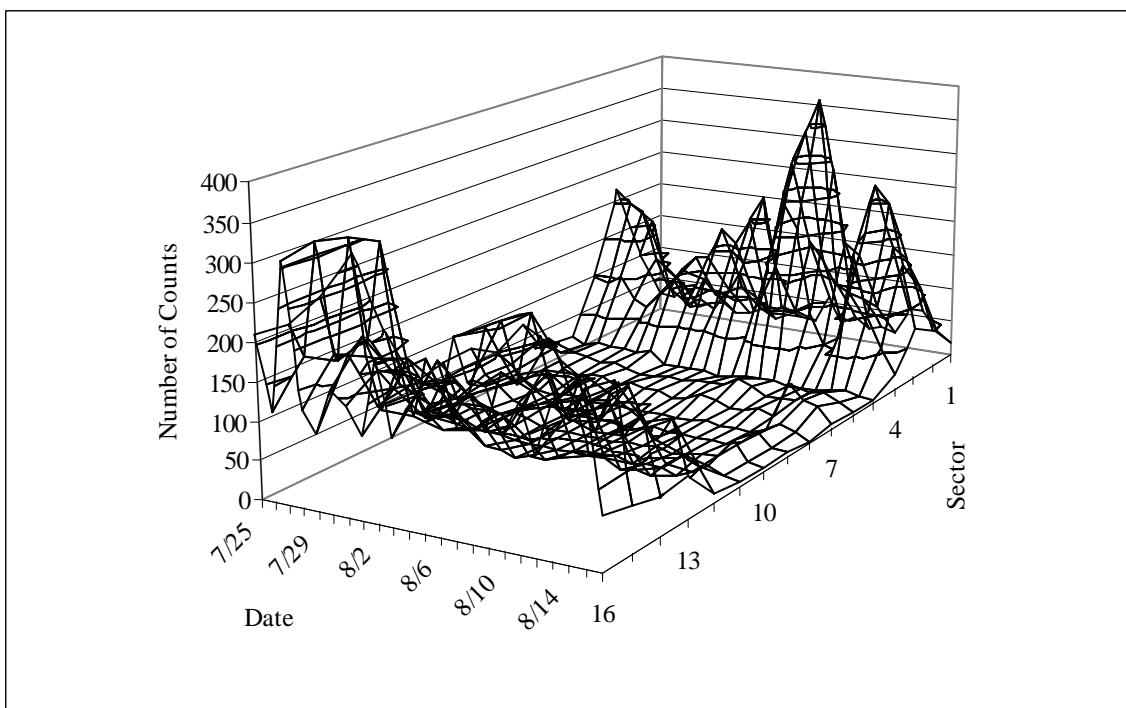


Figure 9.—Sonar counts by day and sector, right bank offshore, Nushagak River sonar project, 25 July–16 August, 2004.

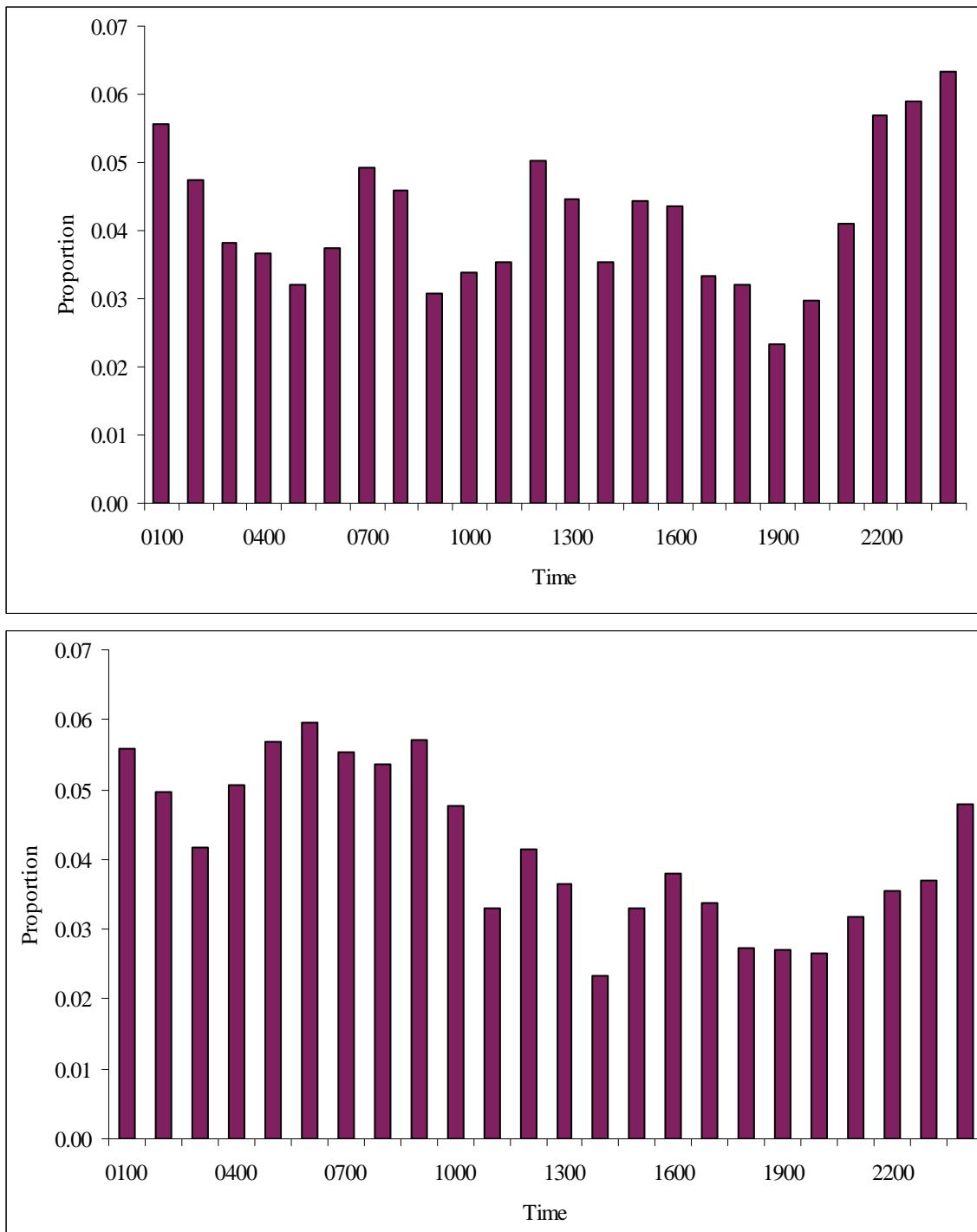


Figure 10.—Average proportion of total sonar counts by hour for the left bank inshore (top) and offshore (bottom), Nushagak River sonar project, 8 June–24 July, 2004.

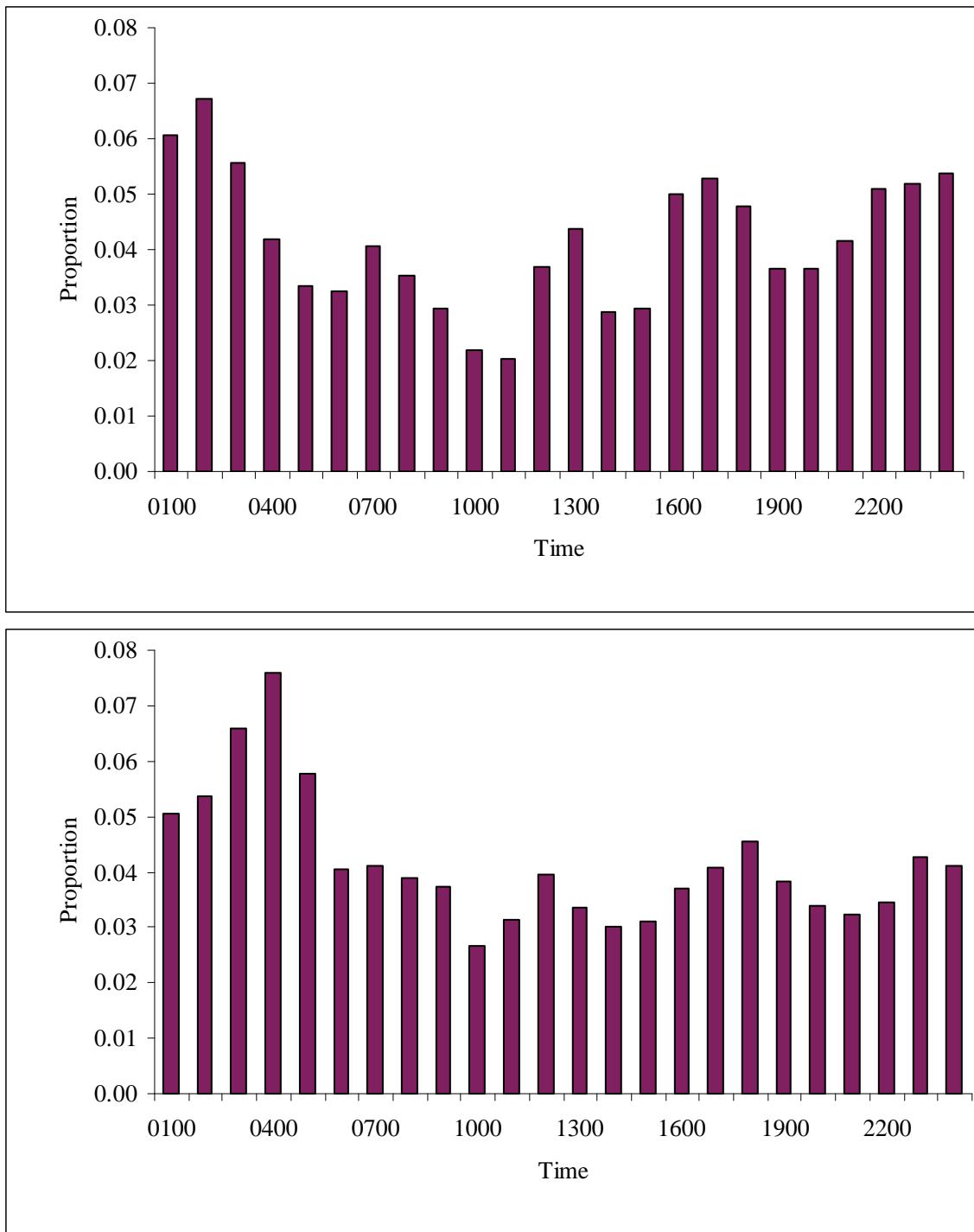


Figure 11.—Average proportion of total sonar counts by hour for the right bank inshore (top) and offshore (bottom), Nushagak River sonar project, 8 June–24 July, 2004.

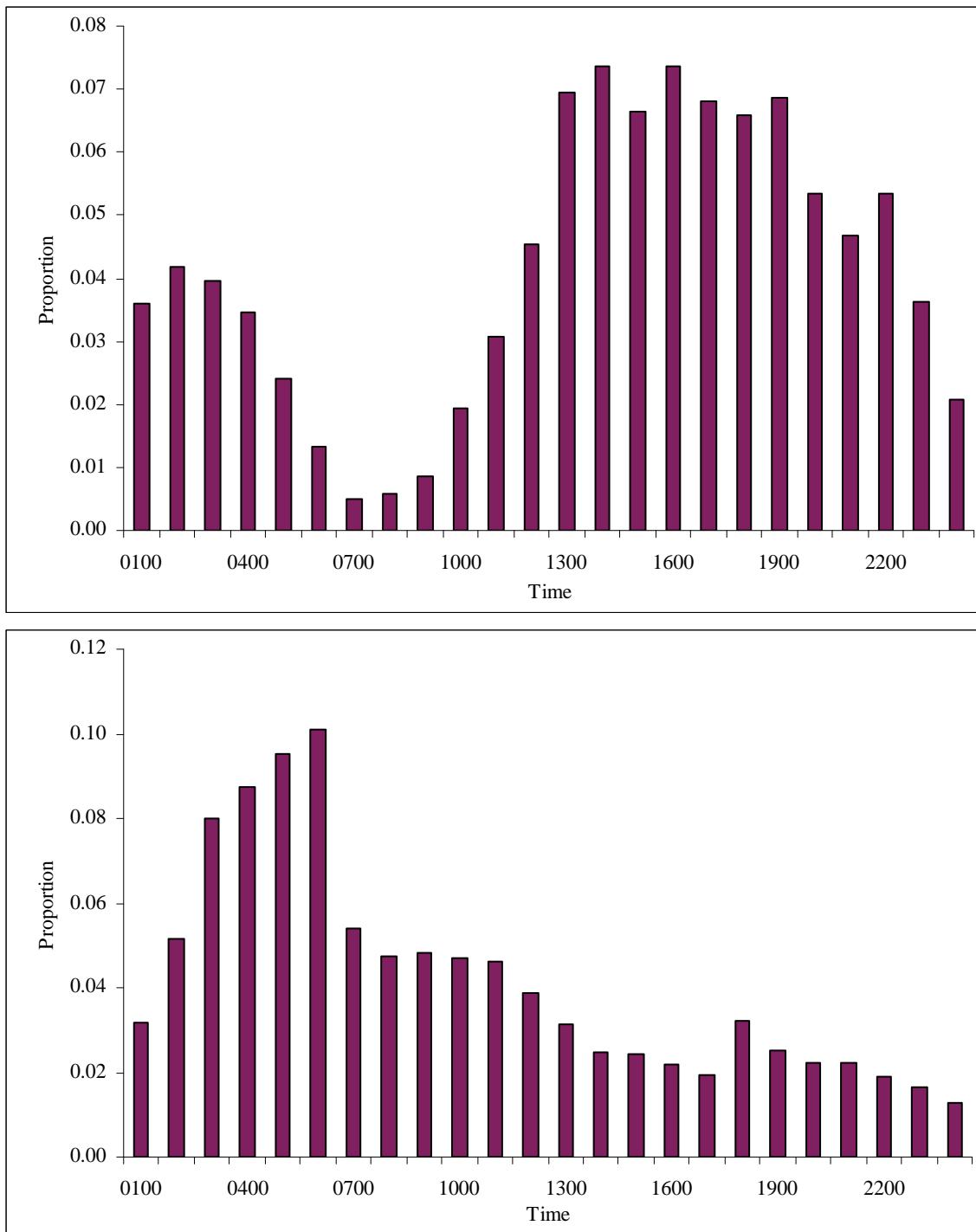


Figure 12.—Average proportion of total sonar counts for the left bank inshore (top) and offshore (bottom), Nushagak River sonar project, 25 July–16 August, 2004.

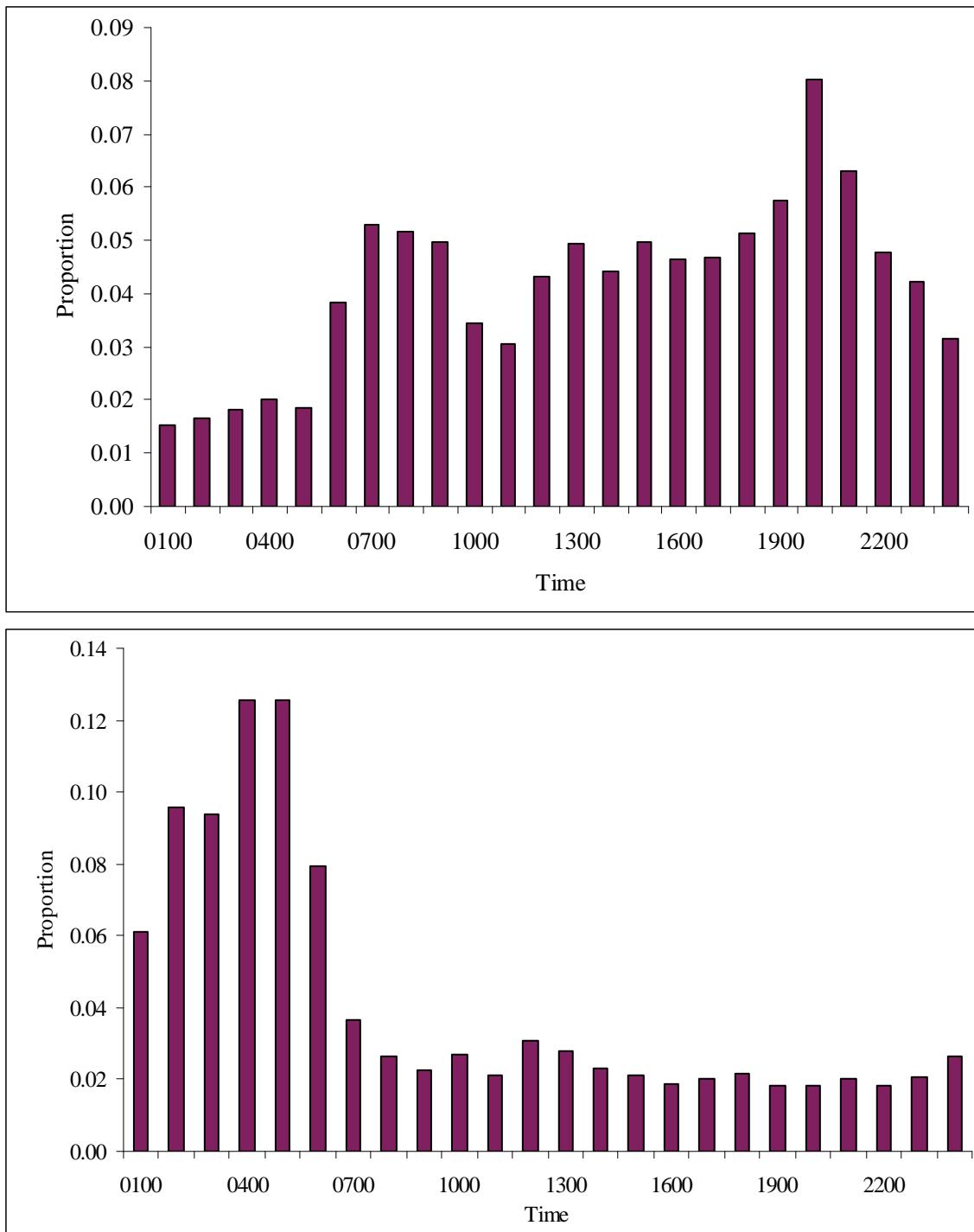


Figure 13.—Average proportion of total sonar counts for the right bank inshore (top) and offshore (bottom), Nushagak River sonar project, 25 July–16 August, 2004.

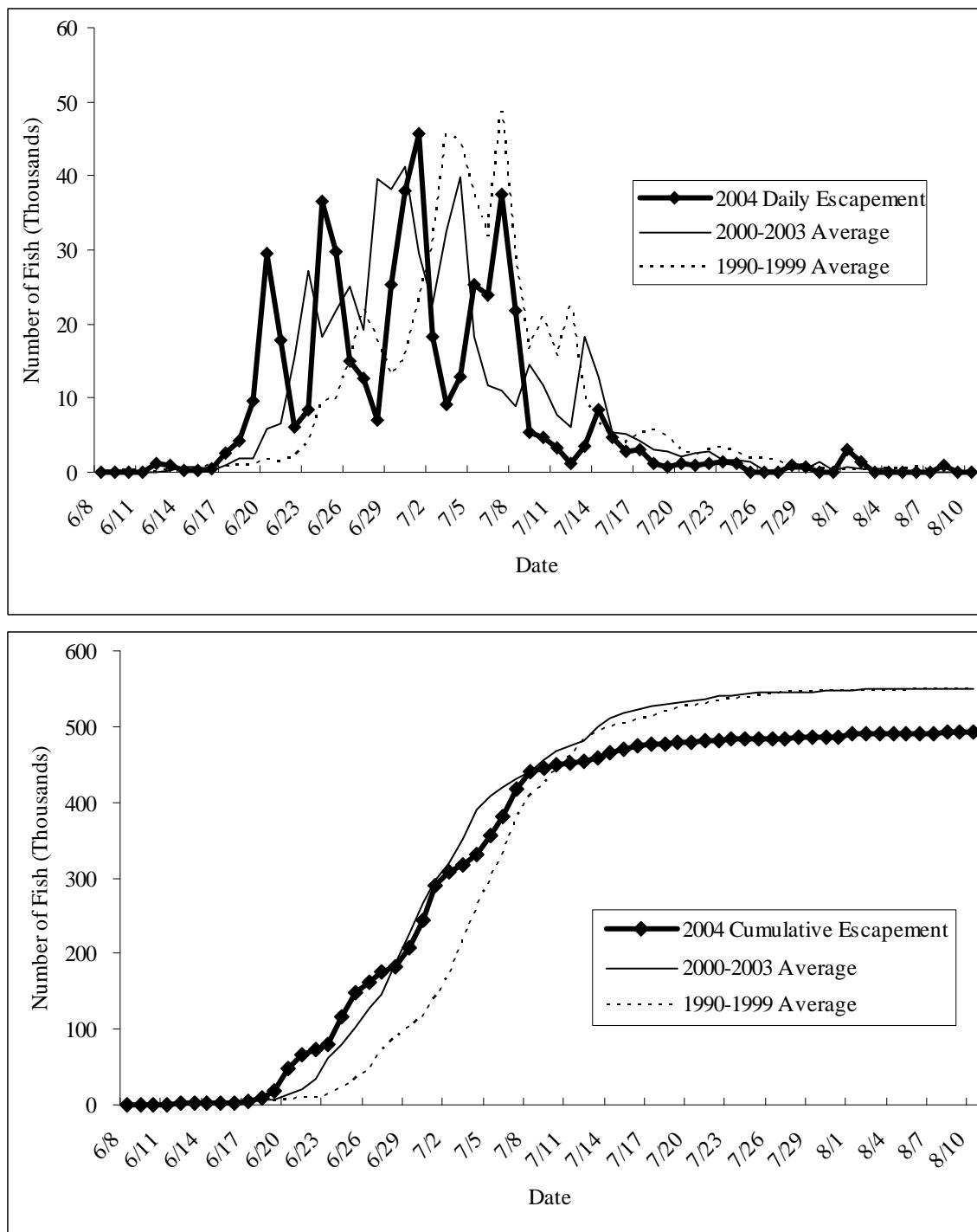


Figure 14.—Average daily (top) and cumulative escapement (bottom) timing for sockeye salmon, Nushagak River sonar project, 8 June–10 August, 2004.

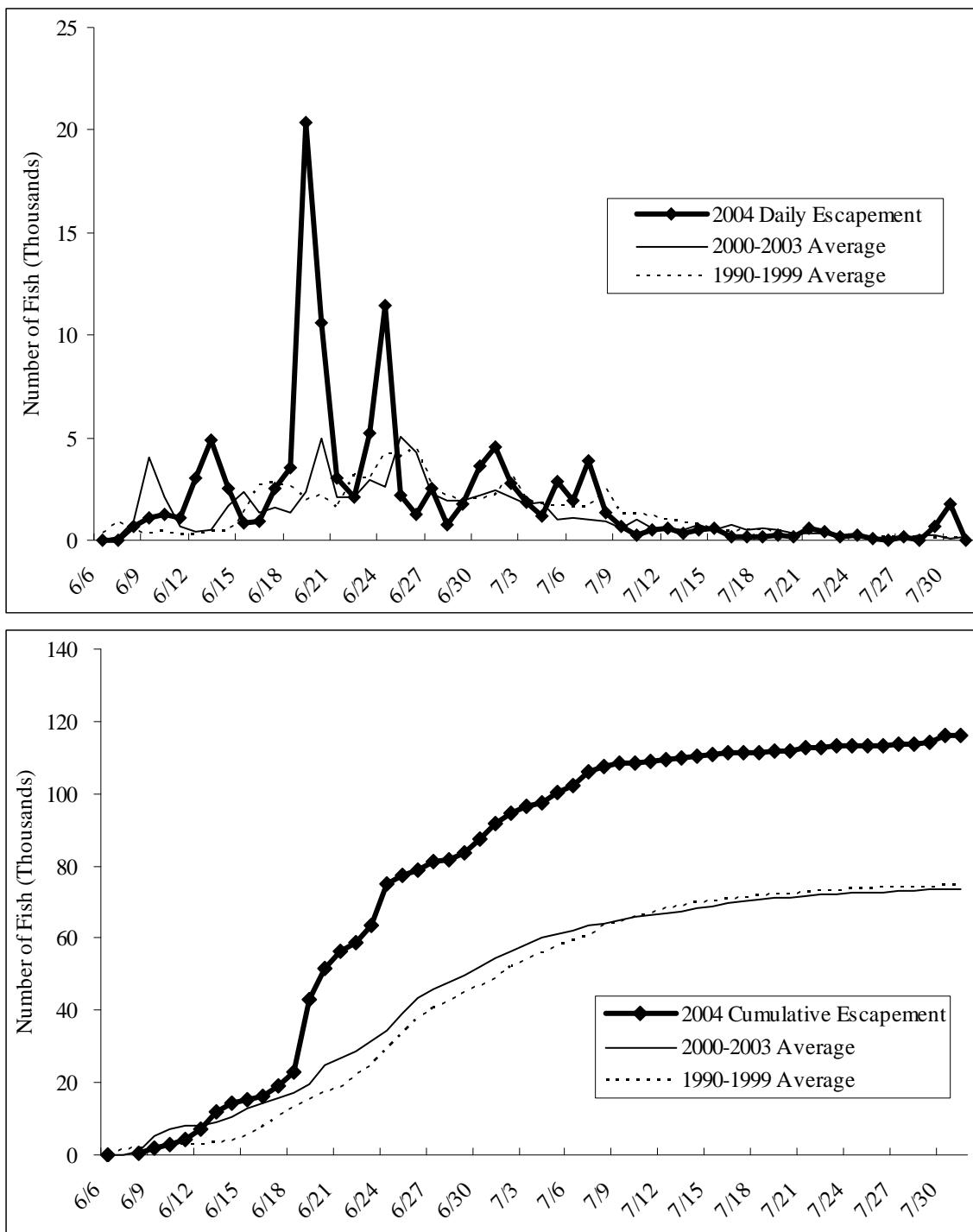


Figure 15.—Average daily (top) and cumulative escapement (bottom) timing for Chinook salmon, Nushagak River sonar project, 6 June–31 July, 2004.

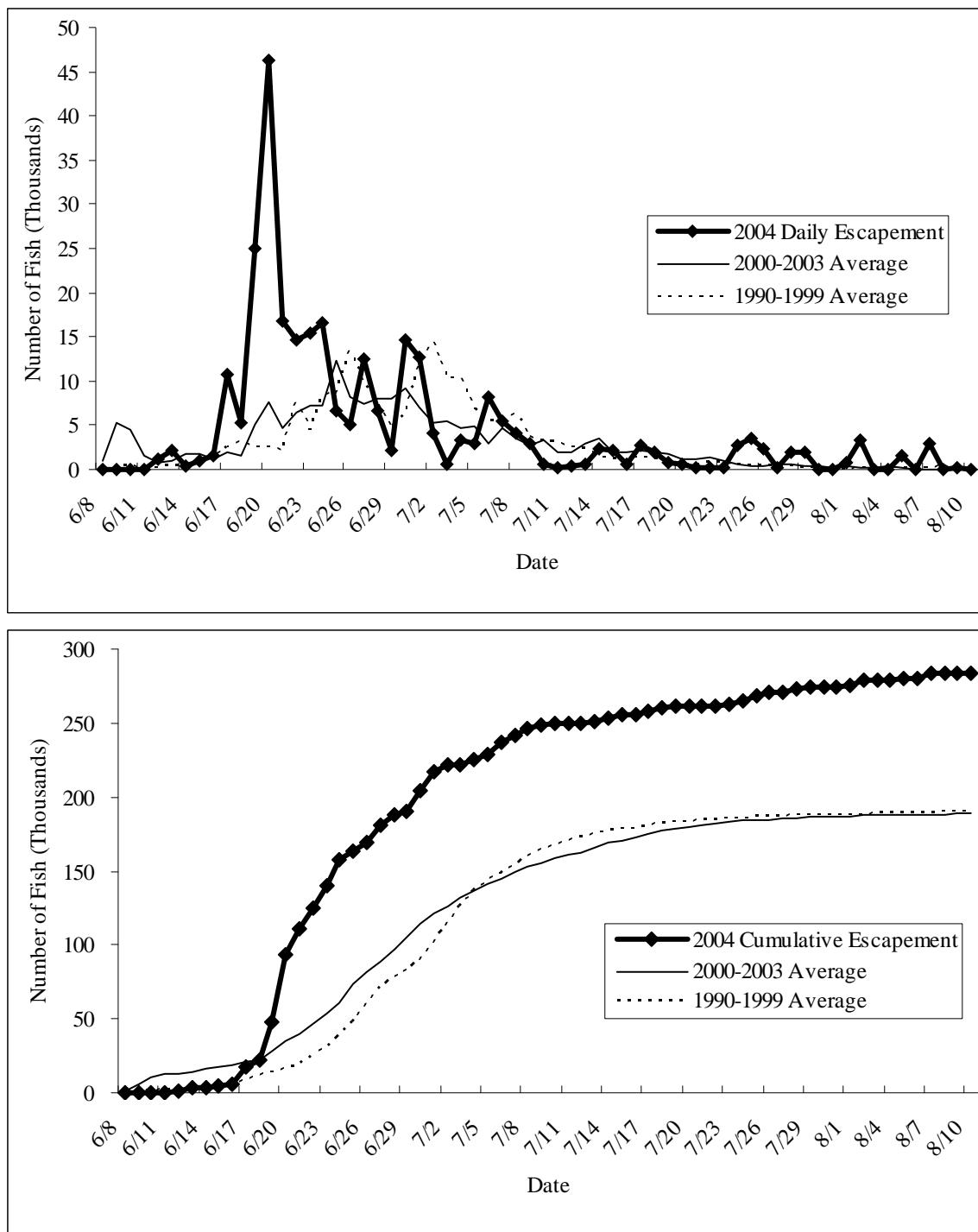


Figure 16.—Average daily (top) and cumulative escapement (bottom) timing for chum salmon, Nushagak River sonar project, 8 June–10 August, 2004.

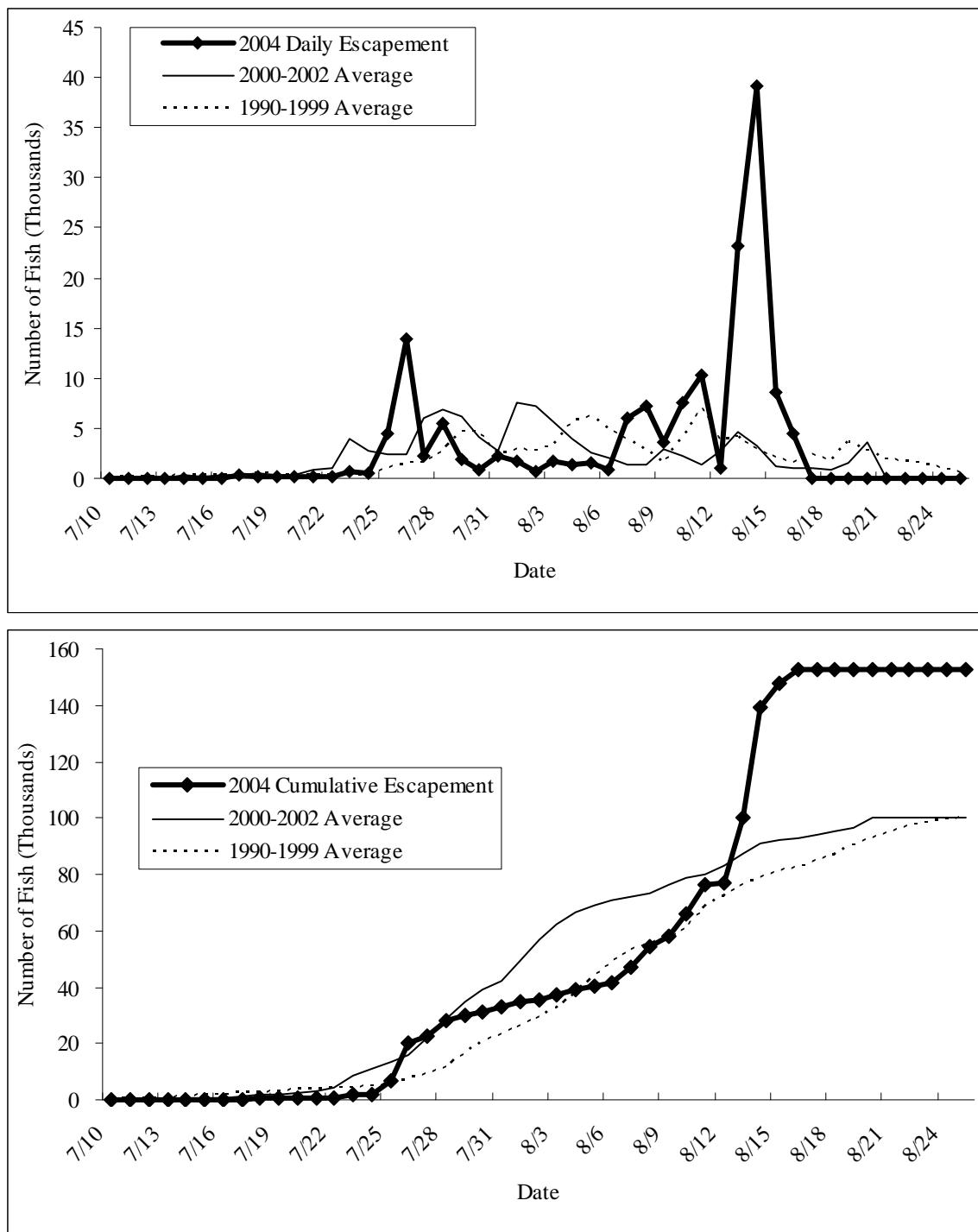


Figure 17.—Average daily (top) and cumulative escapement (bottom) timing for coho salmon, Nushagak River sonar project, 10 July–25 August, 2004.

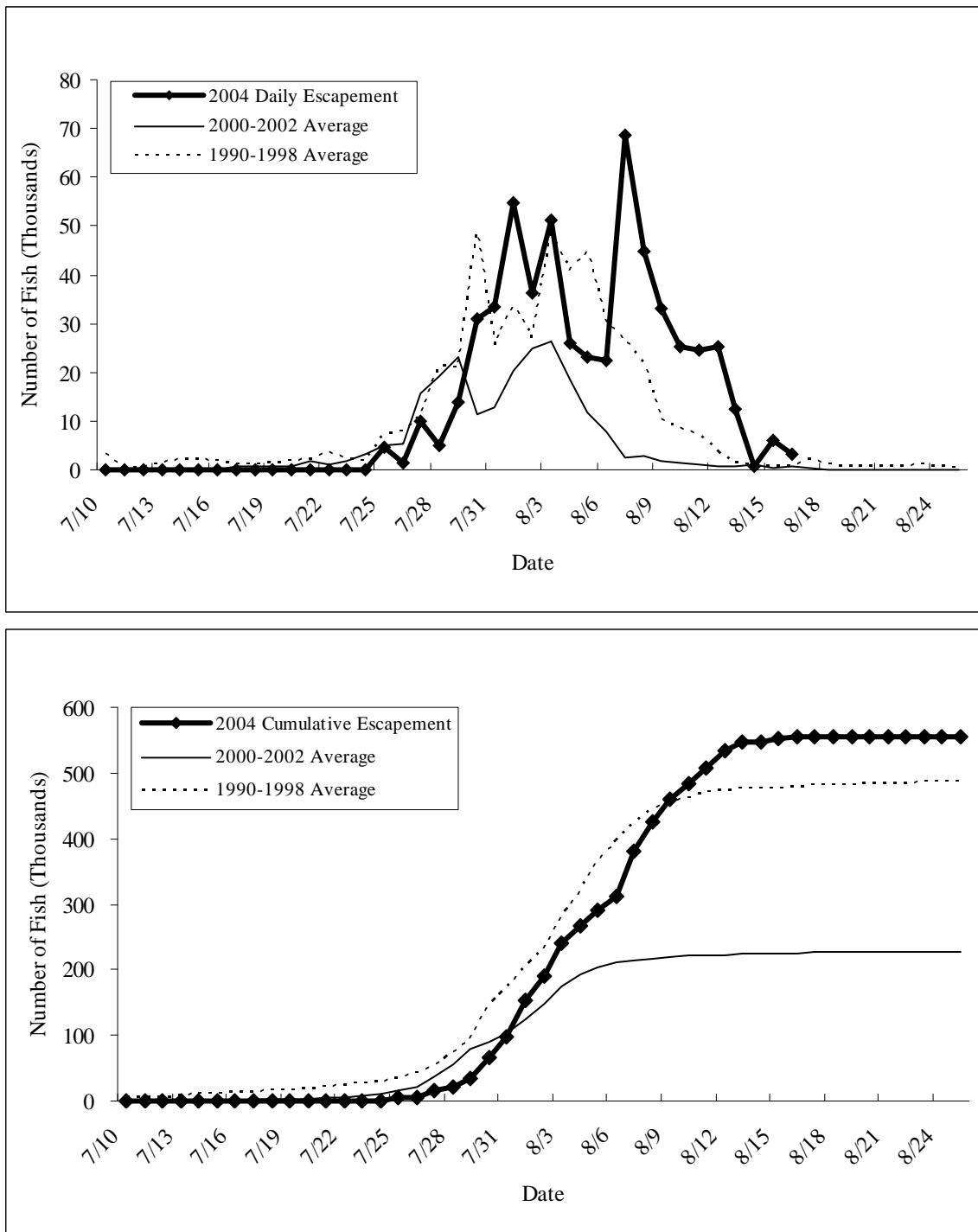


Figure 18.—Average daily (top) and cumulative escapement (bottom) timing for pink salmon, Nushagak River sonar project, 10 July–25 August, 2004.

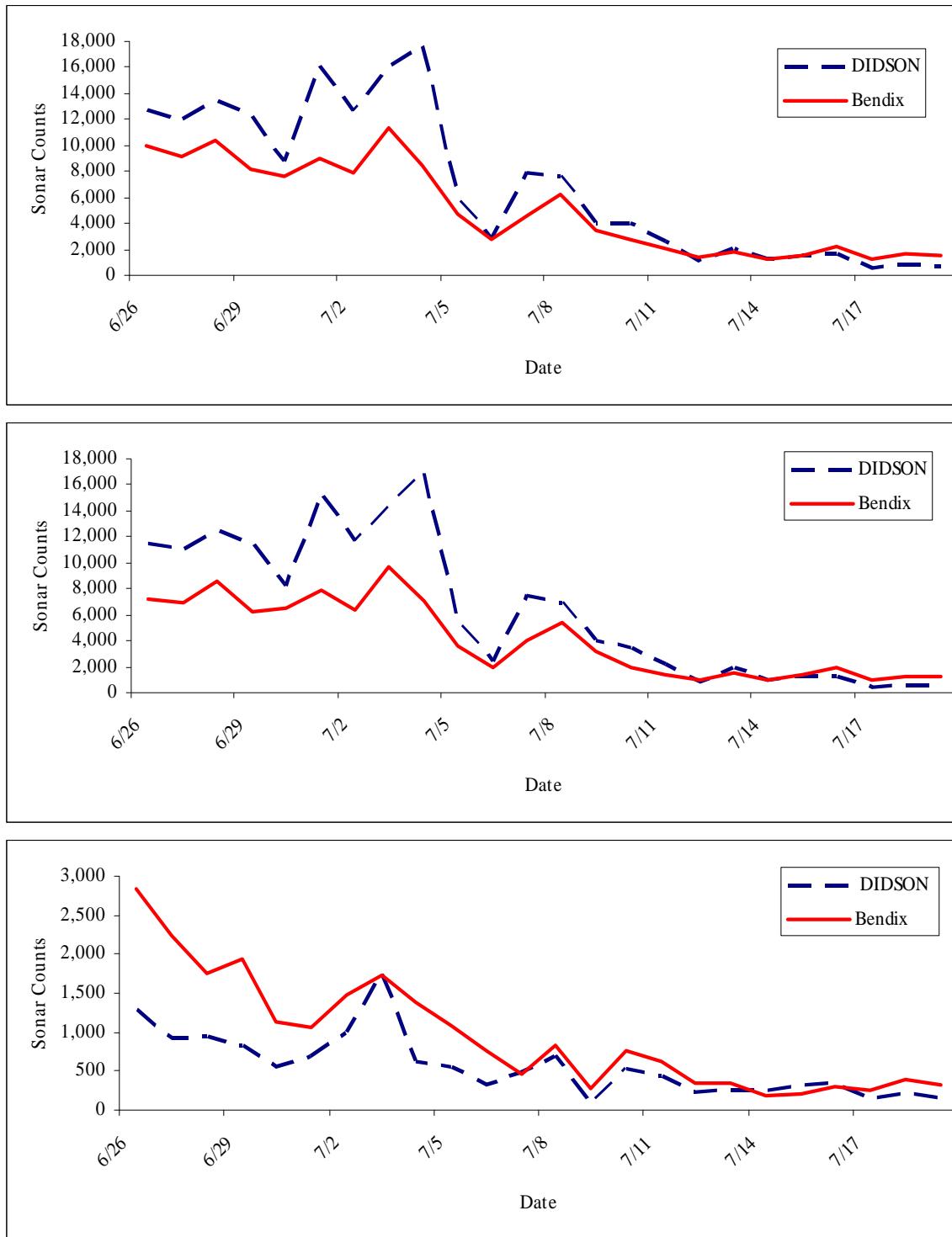


Figure 19.—DIDSON and Bendix left bank paired daily counts, total (top), inshore stratum (middle), and offshore stratum (bottom), Nushagak River sonar project, 26 June–19 July, 2003.

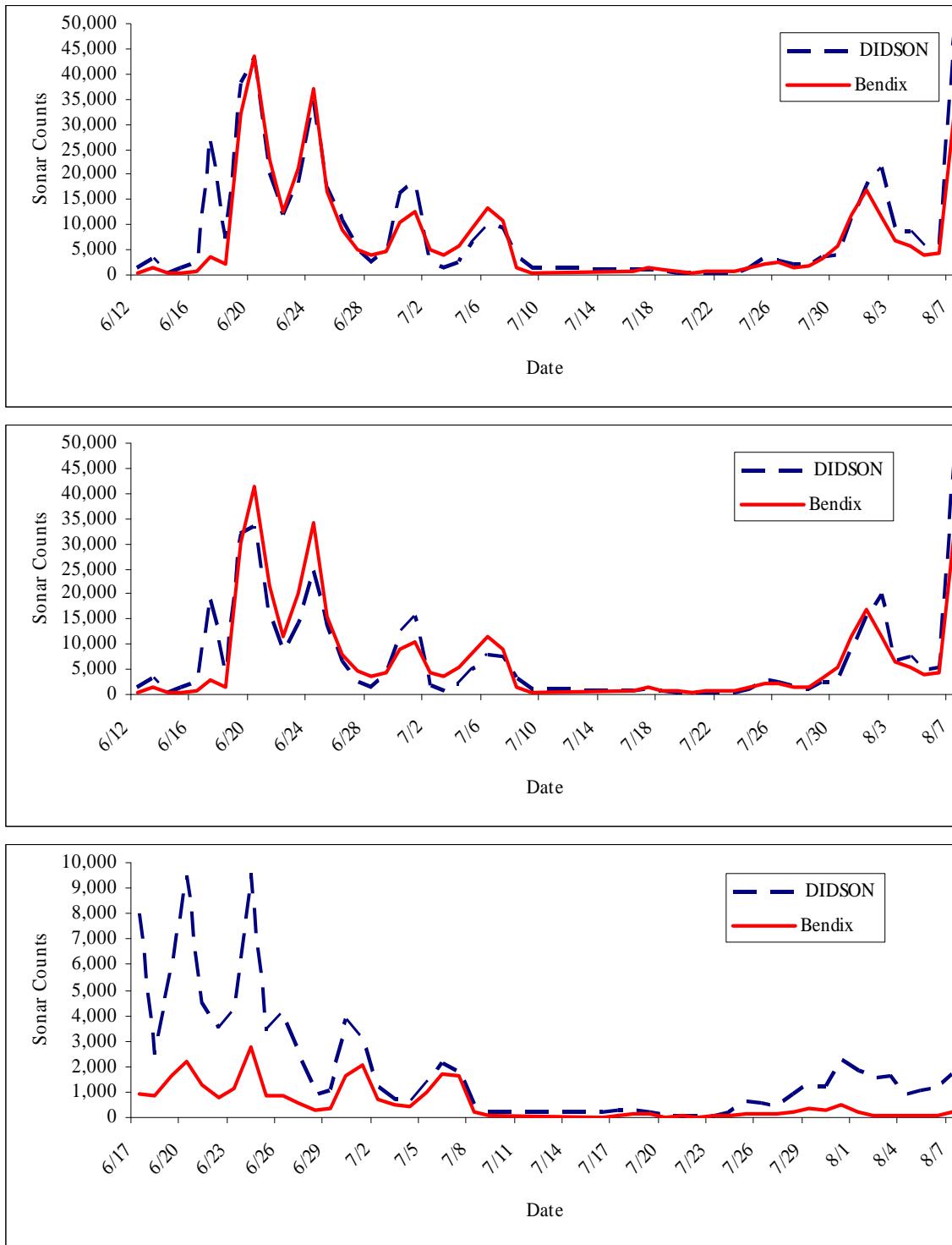


Figure 20.—DIDSON and Bendix left bank paired daily counts, total (top) and inshore stratum (middle), 12 June–7 August; offshore stratum (bottom), 16 June–7 August; Nushagak River sonar project, 2004.

APPENDIX A

Appendix A1.—Sonar counts by date and sector, left bank inshore stratum, Nushagak sonar project, 2004.

Date	Sector												Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12		
6/08	3	10	15	22	60	47	22	25	24	51	9	29	317	317
6/09	55	17	14	41	61	29	16	15	24	59	10	33	374	691
6/10	11	13	15	28	56	26	11	14	393	326	28	83	1,004	1,695
6/11	27	20	6	21	36	16	10	58	337	200	22	27	780	2,475
6/12	49	16	29	76	138	24	32	78	256	112	58	34	902	3,377
6/13	21	16	23	145	318	78	88	265	655	480	224	45	2,358	5,735
6/14	32	52	21	23	31	20	55	92	527	560	75	1	1,489	7,224
6/15	3	14	6	12	1	17	23	46	102	202	46	19	491	7,715
6/16	24	16	30	12	0	28	58	229	115	253	62	35	862	8,577
6/17	33	11	349	101	198	195	290	704	271	385	88	96	2,721	11,298
6/18	80	77	19	349	295	98	141	175	63	34	38	55	1,424	12,722
6/19	62	768	232	4,876	9,943	6,709	3,165	1,537	991	647	583	841	30,354	43,076
6/20	79	115	3,067	8,470	9,393	7,269	4,683	2,777	2,108	1,021	605	1,661	41,248	84,324
6/21	81	69	1,575	4,005	4,416	3,320	2,235	2,066	2,024	598	452	729	21,570	105,894
6/22	28	43	677	1,465	1,412	1,403	1,538	1,946	1,931	447	334	451	11,675	117,569
6/23	42	14	64	799	3,029	4,650	4,451	3,405	2,661	457	341	364	20,277	137,846
6/24	54	13	446	3,263	6,087	7,057	7,214	4,325	3,337	889	654	798	34,137	171,983
6/25	185	10	82	1,169	2,818	3,315	3,234	2,156	1,728	298	302	285	15,582	187,565
6/26	87	16	9	212	670	1,151	1,883	1,670	1,520	337	240	241	8,036	195,601
6/27	23	8	23	24	120	359	1,223	1,170	1,041	254	188	140	4,573	200,174
6/28	44	24	12	46	55	160	821	1,054	1,077	122	86	81	3,582	203,756
6/29	64	21	23	47	291	642	1,082	769	665	280	215	217	4,316	208,072
6/30	209	38	22	196	914	1,414	1,873	1,830	1,716	325	227	240	9,004	217,076
7/01	78	30	223	1,077	1,635	1,378	1,840	1,835	1,690	109	181	478	10,554	227,630
7/02	77	45	34	77	117	210	816	1,260	1,295	54	110	195	4,290	231,920
7/03	123	47	14	52	74	114	511	1,107	1,246	75	76	59	3,498	235,418
7/04	84	26	189	363	365	314	1,420	1,259	1,160	135	86	33	5,434	240,852
7/05	72	71	273	837	913	581	1,879	1,669	1,538	193	124	82	8,232	249,084

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Date	Sector												Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12		
7/06	97	97	938	1,525	1,377	1,100	1,919	1,598	1,423	585	452	354	11,465	260,549
7/07	146	860	3,798	5,848	2,864	1,243	1,675	1,412	1,279	397	339	141	20,002	280,551
7/08	99	965	2,262	2,077	979	499	1,432	1,282	1,127	352	271	188	11,533	292,084
7/09	64	183	499	495	251	199	176	98	94	65	75	73	2,272	294,356
7/10	37	116	262	219	180	87	65	0	77	97	64	44	1,248	295,604
7/11	64	74	143	177	155	144	83	0	73	88	53	40	1,094	296,698
7/12	19	106	83	100	120	100	76	6	29	76	46	25	786	297,484
7/13	69	118	135	142	98	65	27	34	31	19	31	40	809	298,293
7/14	128	206	455	1,128	682	287	209	157	118	73	35	85	3,563	301,856
7/15	174	293	417	477	232	115	107	59	31	22	22	67	2,016	303,872
7/16	45	66	118	268	109	42	17	28	12	10	18	28	761	304,633
7/17	60	84	98	269	234	138	95	68	49	57	48	60	1,260	305,893
7/18	65	76	84	153	140	76	62	43	40	27	46	59	871	306,764
7/19	86	128	70	71	54	26	40	22	34	19	14	57	621	307,385
7/20	43	66	70	158	101	49	43	48	21	31	24	84	738	308,123
7/21	44	64	92	147	84	66	16	27	17	9	15	87	668	308,791
7/22	83	86	103	130	73	71	22	15	11	17	62	100	773	309,564
7/23	46	89	113	152	72	57	36	31	25	12	18	110	761	310,325
7/24	69	161	199	313	139	85	59	45	41	38	31	240	1,420	311,745
7/25	45	107	282	613	341	130	76	62	83	60	57	277	2,133	313,878
7/26	27	35	253	661	408	149	99	90	120	116	80	255	2,293	316,171
7/27	35	38	181	335	249	92	59	76	55	38	69	116	1,343	317,514
7/28	50	205	287	334	179	104	92	56	40	56	54	159	1,616	319,130
7/29	243	730	506	410	280	135	126	107	69	94	132	226	3,058	322,188
7/30	439	1,364	1,065	826	354	257	141	171	171	120	142	345	5,395	327,583
7/31	2,162	3,116	2,305	1,270	762	406	274	487	250	156	159	111	11,458	339,041
8/01	1,498	5,716	4,544	2,288	905	445	258	222	377	145	140	223	16,761	355,802
8/02	341	2,406	3,569	2,444	976	348	229	192	471	159	118	219	11,472	367,274

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Date	Sector												Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12		
8/03	263	1,389	2,120	1,238	506	184	155	119	198	97	85	247	6,601	373,875
8/04	277	1,514	1,777	1,020	381	102	73	47	151	42	39	102	5,525	379,400
8/05	269	897	1,133	711	239	145	96	75	120	58	69	146	3,958	383,358
8/06	102	546	984	1,232	644	139	134	116	198	87	81	129	4,392	387,750
8/07	7,101	11,499	6,814	3,776	1,288	343	241	141	578	138	106	288	32,313	420,063
8/08	2,165	11,506	10,181	5,187	2,408	540	337	261	864	188	130	428	34,195	454,258
8/09	1,909	6,884	8,241	4,557	1,482	519	279	247	276	171	166	317	25,048	479,306
8/10	94	2,310	7,383	9,339	3,936	827	464	341	362	183	163	536	25,938	505,244
8/11	2,345	3,751	8,365	7,839	2,525	654	416	269	147	180	186	566	27,243	532,487
8/12	206	2,100	6,554	5,655	1,613	472	354	256	182	246	157	832	18,627	551,114
8/13	257	4,992	10,063	8,701	2,567	626	455	302	220	195	248	1,100	29,726	580,840
8/14	167	939	5,360	10,978	6,014	1,905	953	701	346	285	253	1,318	29,219	610,059
8/15	82	433	1,419	2,381	1,728	809	531	450	317	226	204	482	9,062	619,121
8/16	30	193	554	766	514	199	206	191	76	100	106	183	3,118	622,239
Total	23,277	68,132	101,377	114,226	81,699	54,615	52,835	43,504	40,716	14,057	10,094	17,863	622,239	

Appendix A2.—Sonar counts by date and sector, left bank offshore stratum, Nushagak sonar project, 2004.

Date	Sector															Daily Total	Cumulative Total	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
6/08	13	64	24	16	8	7	2	0	5	0	11	0	0	0	0	0	150	150
6/09	27	71	53	54	53	18	8	1	14	2	27	14	0	0	0	0	342	492
6/10	4	22	34	39	10	9	6	1	0	1	15	6	0	0	0	0	147	639
6/11	22	37	35	23	13	4	3	4	0	10	22	3	4	0	0	0	180	819
6/12	108	906	611	286	183	66	19	9	41	23	1	0	0	0	0	0	2,253	3,072
6/13	136	1,176	817	458	218	141	29	8	91	54	53	8	0	0	0	0	3,189	6,261
6/14	74	277	187	97	70	22	8	4	32	5	6	13	0	0	0	0	795	7,056
6/15	52	163	28	5	4	0	0	0	0	0	0	0	0	0	0	0	252	7,308
6/16	60	194	14	0	0	0	0	0	0	0	0	0	0	0	0	0	268	7,576
6/17	251	555	97	6	0	0	0	0	0	0	0	0	0	0	0	0	909	8,485
6/18	184	500	121	19	0	0	0	0	1	0	0	0	0	0	0	0	825	9,310
6/19	286	1,208	81	41	23	0	0	0	0	0	0	0	0	0	0	0	1,639	10,949
6/20	427	1,566	163	41	8	1	0	0	0	0	0	0	0	0	0	0	2,206	13,155
6/21	297	794	180	20	4	0	0	0	0	0	1	0	0	0	0	0	1,296	14,451
6/22	191	557	26	7	0	1	0	0	0	0	0	0	0	0	0	0	782	15,233
6/23	281	759	61	8	1	3	2	0	0	0	0	0	0	0	0	0	1,115	16,348
6/24	499	1,983	242	18	2	0	0	0	0	0	0	0	0	0	0	0	2,744	19,092
6/25	257	535	62	9	0	0	0	0	0	0	0	0	0	0	0	0	868	19,960
6/26	215	630	34	3	0	0	0	0	0	0	0	0	0	0	0	0	882	20,842
6/27	174	344	21	3	7	3	43	0	0	0	0	0	0	0	0	0	595	21,437
6/28	28	179	43	7	7	2	2	0	0	0	0	0	0	0	0	0	268	21,705
6/29	21	180	71	17	13	14	7	0	1	2	0	0	0	0	0	1	327	22,032
6/30	145	755	408	116	74	72	17	5	3	2	1	1	0	0	1	0	1,600	23,632
7/01	208	970	430	181	129	79	61	6	9	6	2	0	0	0	1	0	2,082	25,714
7/02	88	302	109	56	26	32	69	6	12	10	0	0	0	0	0	0	710	26,424
7/03	34	110	121	100	21	23	70	0	8	2	0	0	0	0	0	2	491	26,915
7/04	12	127	133	91	26	15	1	0	0	1	0	0	0	0	2	14	422	27,337
7/05	41	392	296	183	41	7	1	1	1	0	0	0	0	0	0	0	963	28,300

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Date	Sector															Daily Total	Cumulative Total	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
7/06	31	625	430	482	117	17	1	3	5	4	0	0	0	0	0	15	1,730	30,030
7/07	55	894	697	753	305	36	6	2	5	2	0	0	0	0	0	0	2,755	32,785
7/08	32	491	282	283	53	2	2	1	5	2	0	0	0	0	0	0	1,153	33,938
7/09	16	177	90	132	17	4	7	0	2	0	0	0	0	0	1	5	451	34,389
7/10	10	103	106	73	11	1	1	0	0	0	0	0	0	0	0	2	307	34,696
7/11	12	92	94	34	0	0	0	0	1	0	0	0	0	0	0	6	239	34,935
7/12	9	30	39	22	2	0	0	0	0	1	0	0	0	0	0	11	114	35,049
7/13	0	10	14	4	1	0	0	0	0	1	0	0	1	0	0	2	33	35,082
7/14	8	22	6	1	0	0	0	0	10	0	0	0	0	2	3	0	52	35,134
7/15	5	9	15	12	5	2	0	0	0	2	0	0	0	0	4	2	56	35,190
7/16	8	11	1	0	1	0	2	0	0	0	0	0	0	0	3	9	35	35,225
7/17	15	30	10	12	6	1	2	1	9	1	2	0	0	0	1	1	91	35,316
7/18	9	45	24	19	18	3	2	0	3	2	0	0	0	0	2	0	127	35,443
7/19	1	29	15	34	28	12	11	2	3	0	0	0	0	0	0	0	135	35,578
7/20	2	17	14	18	10	9	3	0	8	0	0	0	0	0	0	0	81	35,659
7/21	5	12	9	11	11	19	5	0	0	0	0	0	0	0	0	0	72	35,731
7/22	5	16	1	0	0	3	1	0	0	0	0	0	0	0	0	0	26	35,757
7/23	12	20	3	7	0	0	11	0	0	0	0	0	0	0	0	0	53	35,810
7/24	19	20	8	20	5	2	0	0	0	0	0	0	0	0	0	0	74	35,884
7/25	40	31	21	27	9	14	0	0	0	0	0	0	0	0	0	0	142	36,026
7/26	25	60	11	23	16	29	0	0	0	0	0	0	0	0	0	0	164	36,190
7/27	21	47	21	26	12	2	3	0	0	0	0	0	0	0	0	0	132	36,322
7/28	13	18	23	32	65	54	14	1	0	0	0	0	0	0	0	0	220	36,542
7/29	17	15	45	76	93	65	16	0	0	0	0	0	0	0	0	0	327	36,869
7/30	36	13	28	72	69	48	6	0	0	0	0	0	0	0	0	0	272	37,141
7/31	50	57	55	100	106	146	6	0	0	0	0	0	0	0	0	0	520	37,661
8/01	13	3	20	38	60	87	0	0	0	0	0	0	0	0	0	0	221	37,882
8/02	2	3	1	3	9	27	21	0	0	0	0	0	0	0	0	0	66	37,948
8/03	11	3	7	4	7	22	25	4	0	0	0	0	0	0	0	0	83	38,031

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Appendix A2.—Page 3 of 3.

Date	Sector															Daily Total	Cumulative Total	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
8/04	6	12	0	4	10	18	17	0	0	0	0	0	0	0	0	0	67	38,098
8/05	18	21	3	15	8	19	3	0	0	0	0	0	0	0	0	0	87	38,185
8/06	0	1	1	10	21	46	6	0	0	0	0	0	0	0	0	0	85	38,270
8/07	10	7	3	23	49	127	10	0	0	0	0	0	0	0	0	0	229	38,499
8/08	7	9	7	42	47	71	19	0	0	0	0	0	0	0	0	0	202	38,701
8/09	8	3	1	10	49	105	13	0	0	0	0	0	0	0	0	0	189	38,890
8/10	8	4	1	4	20	66	10	0	0	0	0	0	0	0	0	0	113	39,003
8/11	21	10	3	21	57	90	20	0	0	0	0	0	0	0	0	0	222	39,225
8/12	66	45	10	109	203	81	11	0	0	0	0	0	0	0	0	0	525	39,750
8/13	44	34	34	126	98	86	9	0	0	0	0	0	0	0	0	0	431	40,181
8/14	67	24	15	60	72	83	104	0	0	0	0	0	0	0	0	0	425	40,606
8/15	80	21	8	14	6	1	2	0	0	0	0	0	0	0	0	0	132	40,738
8/16	41	14	4	24	32	2	0	0	0	0	0	0	0	0	0	0	117	40,855
Total	4,995	18,468	6,688	4,692	2,659	1,931	731	75	287	153	163	69	31	30	48	107	40,855	

Appendix A3.—Sonar counts by date and sector, right bank inshore stratum, Nushagak sonar project, 2004.

Date	Sector												Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12		
6/08	19	10	6	11	30	27	26	24	11	10	5	14	193	193
6/09	136	41	16	50	30	42	20	8	3	12	6	11	375	568
6/10	5	13	6	6	24	15	15	2	3	1	4	4	98	666
6/11	0	1	10	10	20	18	22	13	4	1	0	3	102	768
6/12	0	3	22	144	500	501	369	272	103	55	4	4	1,977	2,745
6/13	0	11	80	381	625	402	258	146	76	53	10	3	2,045	4,790
6/14	20	32	41	69	125	151	118	68	21	25	6	0	676	5,466
6/15	46	42	15	112	390	260	158	132	62	57	15	3	1,292	6,758
6/16	62	16	84	308	469	308	158	189	93	93	17	9	1,806	8,564
6/17	35	168	597	1,236	3,010	2,787	2,065	1,175	473	269	44	6	11,865	20,429
6/18	61	322	1,163	2,013	2,856	1,715	1,122	585	286	165	46	16	10,350	30,779
6/19	12	49	433	2,229	5,605	4,919	3,980	3,088	1,251	377	24	5	21,972	52,751
6/20	50	1,323	6,706	10,627	9,792	5,262	4,040	2,415	980	361	47	3	41,606	94,357
6/21	26	318	1,868	3,973	4,222	2,134	1,115	518	221	92	17	5	14,509	108,866
6/22	23	119	923	1,856	3,148	2,150	1,274	609	186	55	10	7	10,360	119,226
6/23	10	61	303	850	1,877	1,719	1,414	890	301	66	26	20	7,537	126,763
6/24	10	231	2,491	6,249	7,771	4,724	3,057	1,883	532	173	51	32	27,204	153,967
6/25	17	252	2,492	4,390	5,211	3,800	3,110	2,081	563	145	14	19	22,094	176,061
6/26	102	182	1,271	2,351	3,603	1,522	1,315	756	233	86	38	63	11,522	187,583
6/27	573	2,051	5,738	4,991	3,392	2,079	2,419	298	108	44	39	126	21,858	209,441
6/28	484	823	3,181	2,614	1,090	665	1,033	136	64	35	30	77	10,232	219,673
6/29	480	715	7,435	8,007	4,169	1,715	841	204	68	45	64	88	23,831	243,504
6/30	289	2,877	14,030	11,411	8,232	4,057	1,607	943	302	166	163	145	44,222	287,726
7/01	246	6,152	21,445	10,612	6,095	2,612	645	476	179	121	95	124	48,802	336,528
7/02	227	1,562	6,279	3,885	3,569	2,003	586	353	157	139	249	104	19,113	355,641
7/03	564	342	1,340	1,497	1,113	1,158	488	311	103	61	45	66	7,088	362,729
7/04	406	126	1,427	3,212	2,322	1,793	916	491	167	112	46	63	11,081	373,810
7/05	559	314	3,459	6,927	4,691	2,714	924	519	197	127	136	112	20,679	394,489
7/06	340	249	2,708	5,589	4,397	2,754	1,417	916	393	183	143	147	19,236	413,725
7/07	300	808	5,350	6,980	3,956	2,069	1,162	862	356	248	161	239	22,491	436,216

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Appendix A3.–Page 2 of 3.

Date	Sector												Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12		
7/08	353	996	3,434	2,921	1,971	1,407	1,046	790	386	210	92	71	13,677	449,893
7/09	93	438	1,659	1,162	712	576	577	381	145	75	39	35	5,892	455,785
7/10	146	295	739	730	552	369	429	277	87	64	27	41	3,756	459,541
7/11	239	89	227	338	323	355	436	265	73	37	27	36	2,445	461,986
7/12	109	70	107	149	129	133	162	89	39	17	10	38	1,052	463,038
7/13	360	264	446	651	571	340	263	139	68	60	72	57	3,291	466,329
7/14	303	425	1,091	1,220	919	547	548	392	250	289	239	309	6,532	472,861
7/15	376	273	649	884	697	394	289	179	89	98	130	146	4,204	477,065
7/16	68	150	369	624	655	202	93	65	31	30	44	51	2,382	479,447
7/17	96	175	220	402	520	643	657	431	198	193	207	256	3,998	483,445
7/18	88	95	167	170	165	135	112	75	42	41	54	96	1,240	484,685
7/19	160	145	105	91	77	58	56	15	4	7	8	19	745	485,430
7/20	73	114	127	173	97	41	30	26	15	14	23	32	765	486,195
7/21	105	163	120	167	110	33	23	12	4	2	3	10	752	486,947
7/22	220	182	152	151	66	15	14	7	4	6	4	13	834	487,781
7/23	160	128	222	291	166	31	20	9	3	4	5	6	1,045	488,826
7/24	134	182	550	933	546	143	82	24	12	5	16	77	2,704	491,530
7/25	132	1,139	2,642	2,614	1,197	325	109	29	16	6	17	85	8,311	499,841
7/26	195	2,383	4,907	3,973	1,673	378	114	64	13	19	29	97	13,845	513,686
7/27	0	1,488	3,817	2,949	946	159	48	11	13	4	6	28	9,469	523,155
7/28	0	2,645	4,708	2,259	512	94	42	16	8	9	1	26	10,320	533,475
7/29	0	4,799	6,994	2,426	495	59	19	16	6	4	7	37	14,862	548,337
7/30	576	9,532	11,338	4,100	894	119	36	27	14	12	16	73	26,737	575,074
7/31	1,139	7,850	8,603	3,970	1,023	130	37	20	5	6	22	69	22,874	597,948
8/01	3,953	18,810	14,125	4,360	663	93	40	38	24	36	47	180	42,369	640,317
8/02	3,695	11,616	8,648	3,960	824	86	36	31	15	15	13	62	29,001	669,318
8/03	6,394	19,463	13,228	5,170	961	83	16	8	3	5	3	39	45,373	714,691
8/04	1,574	6,944	7,435	3,795	885	60	16	7	3	12	9	38	20,778	735,469

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Date	Sector												Daily Total	Cumulative Total
	1	2	3	4	5	6	7	8	9	10	11	12		
8/05	1,429	6,842	6,964	4,280	1,481	164	40	13	6	4	3	42	21,268	756,737
8/06	1,240	6,068	5,980	3,449	974	98	30	16	2	3	8	32	17,900	774,637
8/07	3,505	15,866	14,619	7,703	1,852	147	24	10	2	2	9	33	43,772	818,409
8/08	463	3,341	5,521	4,999	2,110	229	43	21	3	2	3	47	16,782	835,191
8/09	151	1,570	3,509	3,378	1,295	125	13	7	4	2	2	53	10,109	845,300
8/10	107	944	2,049	1,863	744	54	9	8	2	5	0	22	5,807	851,107
8/11	166	1,243	2,468	1,896	534	38	4	2	2	2	1	26	6,382	857,489
8/12	824	1,588	2,042	1,345	344	46	31	9	3	6	6	21	6,265	863,754
8/13	53	473	1,156	1,190	558	170	60	25	7	5	14	63	3,774	867,528
8/14	1,013	3,529	2,470	1,142	401	113	39	18	12	7	8	80	8,832	876,360
8/15	808	1,773	935	417	139	46	29	25	8	12	10	45	4,247	880,607
8/16	430	1,623	1,290	599	172	38	20	10	3	6	6	16	4,213	884,820
Total	36,034	154,930	236,757	185,492	121,297	64,363	41,380	23,986	9,138	4,733	2,817	4,049	884,820	

Appendix A4.—Sonar counts by date and sector, right bank offshore stratum, Nushagak sonar project, 2004.

Date	Sector															Daily Total	Cumulative Total	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
6/09	0	2	5	0	0	0	0	12	7	2	0	0	0	0	0	0	28	28
6/10	7	6	0	0	0	0	0	3	1	0	0	0	0	0	0	0	17	45
6/11	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	4	49
6/12	0	5	22	22	11	22	36	35	20	4	0	0	0	0	0	0	177	226
6/13	0	10	12	4	8	10	28	40	37	40	1	0	0	0	5	5	200	426
6/14	0	0	12	8	5	11	24	18	44	7	0	0	0	0	0	0	129	555
6/15	1	2	0	4	4	2	0	4	21	14	0	0	0	0	0	0	52	607
6/16	7	4	1	1	0	1	2	3	15	16	4	0	0	0	0	0	54	661
6/17	0	1	15	4	5	12	12	29	52	80	11	0	0	0	0	0	221	882
6/18	4	51	57	41	15	4	13	18	46	110	10	2	0	0	0	0	371	1,253
6/19	0	16	39	25	16	13	78	170	266	303	32	0	0	0	0	0	958	2,211
6/20	0	76	221	148	54	50	133	155	234	225	23	0	1	1	0	0	1,321	3,532
6/21	0	8	21	10	21	7	17	15	61	55	3	0	0	0	0	0	218	3,750
6/22	0	9	29	11	4	8	5	24	32	26	7	0	0	0	1	0	156	3,906
6/23	0	7	14	24	2	8	19	14	62	64	3	0	0	0	0	1	218	4,124
6/24	4	26	55	32	43	77	92	45	79	33	8	3	2	0	0	0	499	4,623
6/25	2	22	15	20	25	24	33	9	31	12	2	0	0	0	0	0	195	4,818
6/26	0	16	122	136	68	69	18	32	169	74	8	11	8	13	11	7	762	5,580
6/27	1	33	120	133	59	92	33	38	120	68	10	4	3	2	3	5	724	6,304
6/28	2	14	59	94	38	47	19	25	59	23	8	5	9	4	4	1	411	6,715
6/29	17	50	115	107	36	38	13	56	97	34	15	7	10	8	4	2	609	7,324
6/30	2	68	323	231	79	58	16	30	215	98	48	32	27	32	25	25	1,309	8,633
7/01	15	119	405	203	63	41	23	67	216	154	43	46	67	79	42	31	1,614	10,247
7/02	6	35	166	131	30	58	12	28	182	103	55	28	49	43	29	17	972	11,219
7/03	7	9	63	90	23	24	14	12	52	32	12	12	13	15	8	16	402	11,621
7/04	13	26	90	115	22	27	10	20	79	65	11	7	12	12	12	20	541	12,162
7/05	9	23	130	196	41	52	4	30	189	155	69	36	74	37	51	48	1,144	13,306
7/06	5	46	234	219	49	36	13	32	240	221	109	70	98	83	59	24	1,538	14,844

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Date	Sector															Daily Total	Cumulative Total	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
7/07	5	79	229	196	38	39	11	36	221	248	48	35	103	65	24	27	1,404	16,248
7/08	2	37	165	109	29	32	12	20	113	95	43	53	23	28	39	26	826	17,074
7/09	5	11	56	80	30	17	11	7	69	29	9	8	13	7	10	10	372	17,446
7/10	4	34	53	53	9	11	4	8	32	23	5	2	3	9	13	1	264	17,710
7/11	2	9	33	79	9	10	0	7	38	24	4	4	4	4	4	6	237	17,947
7/12	3	2	24	48	14	7	3	5	35	20	11	3	5	5	2	8	195	18,142
7/13	6	23	31	36	1	3	2	3	23	27	11	19	33	32	14	2	266	18,408
7/14	30	118	130	42	3	1	20	27	53	49	68	102	120	121	126	119	1,129	19,537
7/15	15	84	123	36	1	9	28	35	62	92	75	108	148	145	107	96	1,164	20,701
7/16	8	17	63	41	2	2	9	13	20	20	42	46	70	47	52	79	531	21,232
7/17	18	79	107	60	4	5	12	40	53	52	64	63	93	86	73	97	906	22,138
7/18	6	39	74	76	4	5	36	42	88	88	86	87	94	121	120	202	1,168	23,306
7/19	4	24	39	41	1	9	12	7	11	23	15	30	19	31	28	39	333	23,639
7/20	10	38	64	60	6	2	10	12	29	22	14	10	45	24	38	42	426	24,065
7/21	4	17	29	99	0	2	6	6	12	7	13	8	54	37	25	30	349	24,414
7/22	1	28	36	76	4	6	4	5	5	7	8	10	35	21	30	15	291	24,705
7/23	10	19	39	128	1	1	11	0	10	9	12	21	42	84	51	47	485	25,190
7/24	7	56	93	141	9	10	17	9	17	17	27	42	59	85	46	65	700	25,890
7/25	25	103	218	99	21	28	75	50	73	69	59	146	269	227	208	210	1,880	27,770
7/26	21	157	199	91	13	19	50	36	40	22	32	78	158	147	170	116	1,349	29,119
7/27	41	89	190	103	18	21	59	15	24	32	22	71	290	309	319	308	1,911	31,030
7/28	12	73	120	73	17	19	18	6	9	13	11	43	135	158	179	127	1,013	32,043
7/29	23	32	79	64	17	14	10	3	3	12	9	28	64	91	181	100	730	32,773
7/30	25	77	108	88	14	18	16	7	11	17	11	33	145	144	208	159	1,081	33,854
7/31	13	57	130	110	22	10	18	7	16	12	9	38	105	144	168	142	1,001	34,855
8/01	16	67	132	77	3	5	7	1	4	4	6	17	76	92	150	107	764	35,619
8/02	24	76	180	88	2	7	15	3	3	4	3	15	89	138	190	208	1,045	36,664
8/03	13	64	159	77	4	9	10	2	5	5	5	9	91	145	162	113	873	37,537
8/04	20	40	196	105	3	8	11	0	3	3	4	15	89	129	195	152	973	38,510
8/05	22	54	233	135	0	11	3	1	2	4	3	14	77	89	131	147	926	39,436

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Date	Sector															Daily Total	Cumulative Total	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		
8/06	19	49	133	84	3	11	6	2	0	2	2	19	128	169	163	148	938	40,374
8/07	60	160	289	156	5	13	16	1	7	5	9	35	160	157	247	251	1,571	41,945
8/08	23	133	337	247	7	24	10	1	3	5	10	31	174	251	257	196	1,709	43,654
8/09	34	99	386	211	6	15	2	4	4	7	2	31	158	181	194	199	1,533	45,187
8/10	20	91	288	92	2	5	5	0	2	0	8	20	117	134	182	141	1,107	46,294
8/11	26	84	183	50	1	6	9	1	3	4	5	22	133	150	203	187	1,067	47,361
8/12	18	76	167	60	2	6	1	0	1	8	0	18	91	114	153	124	839	48,200
8/13	59	168	273	186	5	21	52	5	9	8	8	38	118	165	209	191	1,515	49,715
8/14	58	152	248	98	10	26	32	18	26	35	19	55	92	178	155	176	1,378	51,093
8/15	31	111	161	57	3	14	27	10	9	9	11	43	125	139	207	216	1,173	52,266
8/16	17	53	71	21	3	4	6	1	6	6	7	13	55	49	59	69	440	52,706
Total	864	3,467	8,219	5,790	1,077	1,288	1,347	1,436	3,799	3,179	1,324	1,770	4,301	4,809	5,376	4,932	52,706	

APPENDIX B

Appendix B1.—Climatological observations for the Nushagak River, 2004.

Date	Cloud Cover ^a		Wind Direction & Velocity (k/hr)		Air Temperature (°C)		Water Temperature (°C)		Precipitation (mm)	Water Color
	800	2000	800	2000	800	2000	800	2000		
6/12	3	3	SW 5-10	Calm	12.2	15.8	10.5	n	Tr ^b	Light Brown
6/13	n	3	n	Calm	5.6	17.8	n	11.0	Tr ^b	Light Brown
6/14	4	n	S 5	Calm	6.7	15.6	10.5	12.5	Tr	Light Brown
6/15	1	4	Calm	E 20	10.6	8.9	n	12.0	0	Light Brown
6/16	4	3	NE 15	NE 15	6.9	15.0	10.5	11.0	Tr ^b	Light Brown
6/17	4	4	Calm	Calm	8.9	7.8	10.5	11.0	Tr ^b	Light Brown
6/18	4	4	Calm	N 15	10.6	13.3	10.0	10.5	Tr ^b	Light Brown
6/19	3	4	Calm	Calm	9.4	16.1	10.0	10.5	0	Light Brown
6/20	2	2	N 10	Calm	12.2	17.2	10.5	15.0	0	Light Brown
6/21	2	2	S 1-2	S 10	11.1	15.0	11.0	13.0	0	Light Brown
6/22	4	4	S 1-2	SW 20	10.6	11.1	12.0	13.0	Tr	Light Brown
6/23	4	4	S 5	SW 5	10.0	13.9	11.5	12.0	Tr ^b	Light Brown
6/24	4	4	S 3	Calm	10.6	10.6	11.5	12.5	Tr ^b	Light Brown
6/25	4	2	Calm	Calm	10.6	21.1	11.5	15.0	0	Light Brown
6/26	2	1	E 1	N 1	12.2	26.7	12.0	15.5	0	Light Brown
6/27	4	1	Calm	S 5-10	15.5	20.6	14.0	16.5	0	Light Brown
6/28	4	1	Calm	NE 5	13.3	21.7	15.0	17.0	Tr ^b	Light Brown
6/29	1	3	Calm	Calm	6.9	20.0	15.0	16.5	Tr ^b	Light Brown
6/30	3	1	Calm	NE 2	11.1	24.4	15.0	18.0	0	Light Brown
7/01	3	4	Calm	Calm	15.0	14.4	16.0	15.0	Tr ^b	Light Brown
7/02	4	4	Calm	Calm	14.4	17.8	14.5	15.0	Tr ^b	Light Brown
7/03	4	3	Calm	Calm	14.4	16.7	14.0	16.0	Tr ^b	Light Brown
7/04	1	1	Calm	W 5	14.4	21.1	14.5	16.5	n	Light Brown
7/05	n	1	SW 20+	SW 10	n	15.0	n	15.0	0	Light Brown
7/06	2	1	Calm	W 20+	10.0	18.3	15.0	17.0	0	Light Brown
7/07	5	4	Calm	SW 10	11.1	22.2	16.0	18.5	0	Light Brown
7/08	1	1	Calm	NE 10	14.4	26.7	17.0	19.5	0	Light Brown
7/09	1	1	Calm	Calm	13.9	24.4	16.5	19.5	0	Light Brown
7/10	1	2	Calm	SW 15	15.6	25.6	17.0	18.5	0	Light Brown
7/11	1	n	Calm	Calm	15.6	25.0	18.0	20.0	0	Light Brown
7/12	1	2	E 10	SW 10	16.1	16.7	16.0	19.0	0	Light Brown
7/13	2	3	Calm	S 10	12.8	16.1	16.0	18.0	0	Light Brown
7/14	4	2	Calm	E 10	13.3	20.0	16.0	19.0	0	Light Brown
7/15	4	3	Calm	S 10	12.2	19.4	17.0	18.0	Tr ^b	Light Brown
7/16	2	4	S 15-20	S 20-25	13.9	13.3	16.5	16.0	0	Light Brown
7/17	4	4	Calm	Calm	12.2	13.9	16.0	16.0	Tr ^b	Light Brown
7/18	4	3	Calm	N 5	13.3	16.1	15.5	16.0	Tr ^b	Light Brown
7/19	1	2	Calm	Calm	11.7	20.6	15.0	16.5	Tr ^b	Light Brown
7/20	2	3	Calm	Calm	9.4	17.2	15.0	16.0	Tr ^b	Light Brown

-continued-

Appendix B1.—Page 2 of 2.

Date	Cloud Cover ^a		Wind Direction & Velocity (k/hr)		Air Temperature (°C)		Water Temperature (°C)		Precipitation (mm)	Water Color
	800	2000	800	2000	800	2000	800	2000		
7/21	3	3	Calm	Calm	13.9	20.0	15.0	18.0	Tr ^b	Light Brown
7/22	1	3	Calm	Calm	12.2	n	15.0	n	0	Light Brown
7/23	4	2	Calm	S 2-3	13.3	18.3	16.0	17.5	0	Light Brown
7/24	2	2	NE 5-10	S 10	13.9	15.6	15.0	16.0	Tr ^b	Light Brown
7/25	4	4	E 5-10	E 10	11.1	12.8	14.0	15.0	Tr ^b	Light Brown
7/26	4	4	Calm	SE 10	12.2	13.3	13.0	14.0	Tr ^b	Light Brown
7/27	4	4	E 10	SE 5	11.7	12.8	13.0	13.5	Tr ^b	Brown
7/28	4	4	Calm	S 5	11.1	13.9	13.0	14.0	Tr ^b	Brown
7/29	4	3	Calm	SW 10	13.3	15.6	13.0	14.0	Tr ^b	Dark Brown
7/30	4	3	Calm	S 10	14.4	15.6	13.0	14.0	Tr ^b	Dark Brown
7/31	2	1	Calm	S 10-15	11.1	20.0	13.5	16.0	0	Brown
8/01	2	1	Calm	SW 20-30	12.8	21.1	13.0	17.0	Tr	Brown
8/02	1	2	Calm	W 5	15.3	18.3	16.0	16.0	0	Brown
8/03	4	4	Calm	Calm	14.4	15.0	16.0	5.0	Tr ^b	Brown
8/04	3	3	Calm	Calm	13.3	16.7	16.0	17.0	0	Brown
8/05	4	3	Variable	Calm	13.9	15.0	16.0	16.0	Tr ^b	Brown
8/06	2	1	Calm	W 10-15	11.1	21.1	14.5	16.0	0	Brown
8/07	2	3	Calm	SW 5	16.7	19.4	16.0	16.0	0	Light Brown
8/08	1	1	Calm	S 5	18.3	22.8	16.0	17.5	0	Light Brown
8/09	1	3	Calm	NE 2-3	15.6	20.0	16.5	18.0	0	Light Brown
8/10	3	2	Calm	Calm	15.6	22.8	17.0	19.0	0	Light Brown
8/11	4	3	SE 5	SE 15	15.6	18.9	17.0	19.0	0	Light Brown
8/12	4	2	SE 10	SE 10-20	15.0	17.8	18.0	18.5	0	Light Brown
8/13	2	2	SE 15	S 20-25	13.9	16.1	17.0	16.0	0	Light Brown
8/14	2	1	SE 10	SE 5-10	15.0	20.0	16.0	17.5	0	Light Brown
8/15	1	2	Calm	W 5-10	15.6	16.7	16.5	18.0	0	Light Brown

Note: n = no observation.

- ^a 1 = cloud cover is less than 1/10 of sky
- 2 = cloud cover not more than 1/2 of sky
- 3 = cloud cover is more than 1/2 of sky
- 4 = clouds completely cover the sky
- 5 = fog or thick haze

^b Precipitation is less than 1.0 mm

APPENDIX C

Appendix C1.—DIDSON and Bendix left bank total paired daily counts, Nushagak River sonar project, 26 June–19 July, 2003.

Date	DIDSON		Bendix		
	Daily Total		Daily Total	Difference	Percent Deviation
6/26/03	12,768		9,992	-2,776	
6/27/03	11,940		9,163	-2,777	
6/28/03	13,398		10,364	-3,034	
6/29/03	12,378		8,193	-4,185	
6/30/03	8,712		7,580	-1,132	
7/01/03	16,074		9,025	-7,049	
7/02/03	12,582		7,830	-4,752	
7/03/03	16,074		11,411	-4,663	
7/04/03	17,706		8,406	-9,300	
7/05/03	6,006		4,704	-1,302	
7/06/03	2,718		2,701	-17	
7/07/03	7,926		4,513	-3,413	
7/08/03	7,650		6,267	-1,383	
7/09/03	4,062		3,478	-584	
7/10/03	3,948		2,709	-1,239	
7/11/03	2,604		2,052	-552	
7/12/03	1,080		1,359	279	
7/13/03	2,124		1,832	-292	
7/14/03	1,218		1,191	-27	
7/15/03	1,566		1,546	-20	
7/16/03	1,620		2,201	581	
7/17/03	582		1,214	632	
7/18/03	780		1,663	883	
7/19/03	720		1,532	812	
Total	166,236		120,926	-45,310	-27.3%

Appendix C2.—DIDSON and Bendix left bank inshore stratum paired daily counts, Nushagak River sonar project, 26 June–19 July, 2003.

Date	DIDSON		Bendix		
	Inshore		Inshore	Difference	Percent Deviation
6/26/03	11,466		7,161	-4,305	
6/27/03	11,010		6,936	-4,074	
6/28/03	12,456		8,619	-3,837	
6/29/03	11,556		6,253	-5,303	
6/30/03	8,166		6,452	-1,714	
7/01/03	15,384		7,952	-7,432	
7/02/03	11,586		6,357	-5,229	
7/03/03	14,316		9,687	-4,629	
7/04/03	17,076		7,010	-10,066	
7/05/03	5,442		3,609	-1,833	
7/06/03	2,406		1,930	-476	
7/07/03	7,434		4,060	-3,374	
7/08/03	6,966		5,443	-1,523	
7/09/03	4,002		3,196	-806	
7/10/03	3,408		1,939	-1,469	
7/11/03	2,160		1,418	-742	
7/12/03	858		1,014	156	
7/13/03	1,872		1,478	-394	
7/14/03	960		995	35	
7/15/03	1,242		1,337	95	
7/16/03	1,272		1,891	619	
7/17/03	432		965	533	
7/18/03	546		1,269	723	
7/19/03	558		1,218	660	
Total	152,574		98,189	-54,385	-35.6%

Appendix C3.—DIDSON and Bendix left bank offshore stratum paired daily counts, Nushagak River sonar project, 26 June–19 July, 2003.

Date	DIDSON		Bendix		
	Offshore		Offshore	Difference	Percent Deviation
6/26/03	1,302		2,831	1,529	
6/27/03	930		2,227	1,297	
6/28/03	943		1,745	802	
6/29/03	822		1,940	1,118	
6/30/03	546		1,128	582	
7/01/03	690		1,073	383	
7/02/03	996		1,473	477	
7/03/03	1,758		1,724	-34	
7/04/03	630		1,396	766	
7/05/03	564		1,095	531	
7/06/03	312		771	459	
7/07/03	492		453	-39	
7/08/03	684		824	140	
7/09/03	60		282	222	
7/10/03	540		770	230	
7/11/03	444		634	190	
7/12/03	222		345	123	
7/13/03	252		354	102	
7/14/03	258		196	-62	
7/15/03	324		209	-115	
7/16/03	348		310	-38	
7/17/03	150		249	99	
7/18/03	234		394	160	
7/19/03	162		314	152	
Total	13,663		22,737	9,074	66.4%

Appendix C4.–DIDSON left bank inshore stratum daily hourly counts, Nushagak River sonar project, 26 June–19 July, 2003.

Hour	Date												Total
	6/26/03	6/27/03	6/28/03	6/29/03	6/30/03	7/1/03	7/2/03	7/3/03	7/4/03	7/5/03	7/6/03	7/7/03	
100	822	108	180	552	78	1,092	852	150		324	30		4,188
200	456	216	210	606	78	984	600	540		96	234		4,020
300	378	450	372	864	120	1,134	216	132		132	66		3,864
400	312	150	132	486	150	288	198	252		84	18		2,070
500	120	114	138	252	18	558	396	264		90	24		1,974
600	576	120	264	420	66	492	462	318		120	12		2,850
700	498	156	444	594	150	840	672	462		150	114		4,080
800	822	312	276	1,458	300	1,158	732	396		102	252		5,808
900	378	396	324	1,128	474	588	1,044	216	1,026	294	138		6,006
1000	540	210	366	990	366	156	216	1,062	402	30	132		4,470
1100	384	54	96	672	228	222	594	468	1,464	486	60		4,728
1200	246	120	546	540	354	2,124	426	510	2,358	252	252		7,728
1300	750	444	186	252	192	168	582	846	2,886	558	84		6,948
1400	336	102	636	468	42	150	414	846	1,542	372	672	1,536	7,116
1500	72	120	1,080	192	264	60	642	2,256	1,440	462	192	1,644	8,424
1600	342	1,362	924	282	438	354	426	1,266	1,290	390	60	420	7,554
1700	336	378	690	78	36	240	342	378	318	48	54	96	2,994
1800	342	534	756	90	192	150	12	330	702	138	0	456	3,702
1900	276	1,314	1,194	414	192	120	654	486	108	132	12	96	4,998
2000	708	1,920	558	180	234	54	630	1,290	600	318		90	6,582
2100	1,050	834	42	30	180	150	30	1,848	1,188	258		666	6,276
2200	774	1,092	1,056	462	1,716	1,536	234		840	330		870	8,910
2300	168	408	1,092	282	1,434	1,350	882		240	204		660	6,720
2400	780	96	894	264	864	1,416	330		672	72		900	6,288

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Hour	Date												Total
	7/8/03	7/9/03	7/10/03	7/11/03	7/12/03	7/13/03	7/14/03	7/15/03	7/16/03	7/17/03	7/18/03	7/19/03	
100	642	360	186	60	18	60	48	66	162	30	6	24	1,662
200	204	372	30	282	6	90	42	12	216	12	0	66	1,332
300	174	210	90	210	12	24	24	48	18	18	12	30	870
400	552	396	126	18	36	66	48	36	54	30	18	12	1,392
500	342	102	48	132	12	54	150	42	60	36	0	-6	972
600	108	102	60	150	12	54	60	84	132	30	24	12	828
700	1,110	18	48	348	96	60	60	48	30	66	48	60	1,992
800	840	6	96	78	72	102	-6	12	78	-24	12	18	1,284
900	108	42	60	24	60	132	12	72	36	54	24	30	654
1000	48	396	48	72	42	114	36	0	24	18	36	0	834
1100	324	144	48	24	6	6	12		60	0	30	30	684
1200	210	144	60	0	-12	54	24		0	18	18	30	546
1300	108	222	78	216	0	42	66		6	24	18	60	840
1400	144	330	60	24	6	36			0	-18	18	84	684
1500	108	138	282	186	6	36			6	30	-6	42	828
1600	450	78	324	12	78	18		18	78	6	24	18	1,104
1700	204	114	372	72	30	54		72	0	30	6	6	960
1800	36	60	318	18	42	60		54	54	6	0	42	690
1900	36	36	504	18	84	72	30	54	66	6	42		948
2000	378	42	222	36	72	330	150	84	42	18	18		1,392
2100	288	48	12	114	72	78	72	60	12	12	18		786
2200	270	198	156	54	60	78	42	168	36	-6	48		1,104
2300	210	246	24	6	12	132	42	126	36	24	24		882
2400	72	198	156	6	36	120	48	186	66	12	108		1,008

Appendix C5.—Bendix left bank inshore stratum daily hourly counts, Nushagak River sonar project, 26 June–19 July, 2003.

Hour	Date												Total
	6/26/03	6/27/03	6/28/03	6/29/03	6/30/03	7/1/03	7/2/03	7/3/03	7/4/03	7/5/03	7/6/03	7/7/03	
100	310	143	100	276	139	292	242	278		95	70		1,945
200	248	148	206	259	152	383	436	251		70	130		2,283
300	242	190	145	306	117	382	220	166		96	80		1,944
400	125	126	88	141	73	203	208	177		58	41		1,240
500	71	65	120	204	37	147	159	121		37	43		1,004
600	191	59	182	296	104	312	199	312		74	37		1,766
700	266	154	108	154	109	375	537	415		137	64		2,319
800	382	744	243	212	84	253	346	303		171	65		2,803
900	212	138	136	387	100	134	160	185	411	87	78		2,028
1000	582	202	174	411	164	145	154	238	263	161	61		2,555
1100	436	181	190	408	218	276	172	416	285	62	103		2,747
1200	472	325	374	269	206	521	376	456	915	48	51		4,013
1300	276	246	187	186	166	190	247	649	793	144	65		3,149
1400	243	155	577	322	113	160	179	632	554	315	233	555	4,038
1500	159	535	717	254	361	215	402	1,057	528	275	262	595	5,360
1600	261	698	353	164	156	172	210	649	454	151	137	250	3,655
1700	347	417	706	137	144	313	103	512	396	76	127	145	3,423
1800	299	386	568	184	213	305	78	409	266	101	96	229	3,134
1900	287	634	323	193	438	237	204	382	246	220	187	169	3,520
2000	531	267	726	202	813	404	369	962	277	262		259	5,072
2100	491	301	587	342	644	563	485	1,117	528	329		693	6,080
2200	314	435	700	359	742	730	432		430	183		467	4,792
2300	237	236	721	331	613	761	207		371	273		322	4,072
2400	179	151	388	256	546	479	232		293	184		376	3,084

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Hour	Date												Total	
	7/8/03	7/9/03	7/10/03	7/11/03	7/12/03	7/13/03	7/14/03	7/15/03	7/16/03	7/17/03	7/18/03	7/19/03		
100	267	88	79	51	24	58	53	50	128	34	46	41	919	
200	188	91	95	68	12	57	88	35	49	27	35	46	791	
300	220	96	47	64	32	51	62	55	61	42	40	55	825	
400	203	46	48	62	35	55	35	47	101	29	94	85	840	
500	134	79	36	23	20	28	35	67	56	17	47	45	587	
600	267	39	50	42	21	29	60	59	85	25	41	69	787	
700	525	32	54	116	48	37	44	27	138	39	49	86	1,195	
800	444	106	74	131	62	48	31	18	161	77	46	61	1,259	
900	125	136	54	60	60	72	19	18	8	43	58	64	717	
1000	270	143	56	95	31	59	72	15	119	20	44	82	1,006	
1100	252	226	84	81	21	44	33		37	23	28	54	883	
1200	268	196	82	44	15	67	66		39	26	44	81	928	
1300	132	174	90	40	33	30	22		31	29	31	95	707	
1400	218	154	80	29	54	75			40	24	40	72	786	
1500	358	146	113	59	43	50			80	56	35	104	1,044	
1600	282	166	122	71	43	37			64	68	44	50	988	
1700	198	190	120	59	65	59			95	56	44	40	983	
1800	140	184	179	30	46	57			90	114	32	49	80	1,001
1900	149	125	127	75	27	162	35	109	92	32	123		1,056	
2000	266	93	55	74	77	136	58	106	116	62	66		1,109	
2100	149	145	76	61	95	85	66	88	82	86	59		992	
2200	135	187	73	51	56	34	103	96	67	66	81		949	
2300	125	184	58	26	38	48	75	180	107	54	60		955	
2400	128	170	87	6	56	100	38	118	56	34	63		856	

Appendix C6.—DIDSON left bank offshore stratum daily hourly counts, Nushagak River sonar project, 26 June–19 July, 2003.

Hour	Date												Total
	6/26/03	6/27/03	6/28/03	6/29/03	6/30/03	7/1/03	7/2/03	7/3/03	7/4/03	7/5/03	7/6/03	7/7/03	
100	150	60	24	36	30	42	72	36		30	30		510
200	6	54	24	36	18	6	60	24		18	18		264
300	48	42	12	24	18	36	6	6		24	0		216
400	30	36	42	6	42	30	18	18		6	18		246
500	30	18	6	24	6	6	-6	6		-6	6		90
600	168	66	72	66	6	6	6	0		24	30		444
700	48	90	96	42	18	12	24	30		36	-6		390
800	36	54	60	180	42	78	30	72		18	6		576
900	36	36	30	30	60	78	126	48	66	30	12		552
1000	6	18	12	18	18	42	78	174	90	0	12		468
1100	42	36	42	30	12	66	66	60	84	48	6		492
1200	54	42	54	48	24	36	78	84	60	18	48		546
1300	78	66	30	48	24	12	66	72	30	54	18		498
1400	48	12	66	36	6	60	42	66	12	90	36	30	504
1500	72	54	36	48	48	0	66	60	6	18	12	60	480
1600	54	24	42	72	24	12	18	768	0	60	30	48	1,152
1700	36	24	96	6	18	6	54	78	36	6	12	48	420
1800	66	18	36	12	30	24	12	60	48	30	6	12	354
1900	30	78	13	6	0	30	66	30	48	18	18	30	367
2000	30	24	42	6	6	12	54	12	36	6		30	258
2100	12	24	12	24	18	24	6	54	42	6		54	276
2200	60	24	18	12	0	12	6		30	6		156	324
2300	48	30	12	6	60	24	42		12	6		12	252
2400	114	0	66	6	18	36	6		30	18		12	306

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Hour	Date												Total
	7/8/03	7/9/03	7/10/03	7/11/03	7/12/03	7/13/03	7/14/03	7/15/03	7/16/03	7/17/03	7/18/03	7/19/03	
100	18	30		36	0	0	12	24	0	12	12	0	144
200	12	78		30	6	0	6	12	18	-6	0	6	162
300	36	18		6	0	-6	0	0	6	12	12	6	90
400	30	24		6	0	6	18	0	12	12	6	0	114
500	36	0		18	0	18	6	-6	6	12	12	6	108
600	12	12		48	48	36	6	12	24	12	0	-6	204
700	12	0		66	42	36	-6	36	6	0	0	12	204
800	72	0		18	18	0	36	6	12	6	0	12	180
900	48	0		6	12	24	6	36	42	0	12	6	192
1000	12	0	12	0	24	0	6	18	36	0	18	6	132
1100	6	-12	0	18	-12	6	0		36	12	0	-6	48
1200	12	-24	12	6	0	0	30		-18	6	0	-24	0
1300	48	-24	18	6	0	12	36		30	-6	12	12	144
1400	54	-18	0	0	-6	0			6	0	-6	36	66
1500	6	-24	24	18	0	18			6	6	12	42	108
1600	12		132	30	0	18		12	6	-6	30	0	234
1700	36		42	12	6	6		12	0	0	18	6	138
1800	36		60	24	12	36		84	24	18	12	48	354
1900	36		60	36	6	-6	12	0	60	-6	30		228
2000	54		36	-6	18	6	6	-6	-18	36	6		132
2100	18		18	30	18	12	42	12	24	6	24		204
2200	78		60	18	0	12	30	6	12	12	12		240
2300	6		48	6	36	12	6	30	12	18	12		186
2400	-6		18	12	-6	6	6	36	6	-6	0		66

Appendix C7.—Bendix left bank offshore stratum daily hourly counts, Nushagak River sonar project, 26 June–19 July, 2003.

Hour	Date												Total
	6/26/03	6/27/03	6/28/03	6/29/03	6/30/03	7/1/03	7/2/03	7/3/03	7/4/03	7/5/03	7/6/03	7/7/03	
100	190	189	40	62	75	52	60	52		83	51		854
200	75	79	46	37	25	43	57	52		36	43		493
300	64	62	44	38	54	18	32	40		53	21		426
400	43	39	36	42	19	13	43	24		28	9		296
500	204	117	51	40	5	16	16	37		27	6		519
600	180	255	183	95	33	32	99	121		58	38		1,094
700	144	212	278	271	38	29	36	107		31	33		1,179
800	129	131	130	199	116	79	63	77		86	22		1,032
900	142	70	141	181	42	64	102	91	86	43	14		976
1000	107	98	97	142	40	47	53	204	180	16	115		1,099
1100	246	85	30	98	32	84	192	121	304	51	14		1,257
1200	139	126	42	107	149	73	96	151	206	147	110		1,346
1300	129	49	25	110	28	49	109	124	136	39	69		867
1400	119	35	65	104	17	46	85	106	35	40	55	56	763
1500	128	79	36	93	23	33	43	111	60	26	71	63	766
1600	105	44	38	57	32	25	72	55	43	38	31	32	572
1700	134	110	64	27	45	26	35	56	50	38	19	56	660
1800	151	81	53	36	59	37	48	55	41	30	33	70	694
1900	82	93	61	27	30	32	28	47	23	7	17	47	494
2000	56	30	45	45	41	30	38	33	31	26		17	392
2100	59	35	58	32	93	30	67	60	55	41		34	564
2200	118	89	77	49	33	85	42		49	45		36	623
2300	46	41	49	17	42	41	27		58	69		30	420
2400	41	78	56	31	57	89	30		39	37		12	470

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Hour	Date												Total
	7/8/03	7/9/03	7/10/03	7/11/03	7/12/03	7/13/03	7/14/03	7/15/03	7/16/03	7/17/03	7/18/03	7/19/03	
100	27	22		16	9	15	10	30	40	25	4	7	205
200	18	38		17	10	15	4	5	20	16	0	3	146
300	34	31		22	9	9	8	5	21	18	26	11	194
400	45	30		19	12	2	7	10	12	5	3	22	167
500	34	20		20	18	4	4	7	21	12	21	4	165
600	37	9		64	29	30	8	9	10	3	49	10	258
700	14	7		64	31	21	10	7	4	14	28	19	219
800	83	6		45	37	30	17	26	20	11	3	51	329
900	41	13		18	22	31	7	3	4	21	13	13	186
1000	36	21	19	15	15	32	14	10	4	2	27	52	247
1100	135	13	40	35	13	9	19		2	6	9	14	295
1200	18	21	44	31	5	6	16		2	0	12	8	163
1300	40	24	24	21	2	2	9		5	0	50	16	193
1400	29	19	43	16	4	16			3	1	26	3	160
1500	52	8	40	11	6	15			4	6	7	13	162
1600	28		104	22	18	4		9	2	19	17	18	241
1700	18		116	56	23	12		3	1	10	1	23	263
1800	27		89	27	17	12		9	13	10	6	27	237
1900	14		42	27	23	34	8	6	28	10	17		209
2000	32		39	14	19	13	12	6	8	26	13		182
2100	13		35	38	9	11	11	17	21	8	19		182
2200	19		64	16	2	2	3	3	16	2	16		143
2300	16		43	10	4	1	6	18	22	14	3		137
2400	14		28	10	8	28	23	26	27	10	24		198

Appendix C8.—DIDSON and Bendix total escapement estimates for the left (south) bank by species, Nushagak River sonar project, 26 June–19 July, 2003.

Total	DIDSON	Bendix	Difference	Percent Deviation
Escapement	166,236	120,926	-45,310	-27.3%
Total Var	69,247,403	20,721,085		
SE	8,322	4,552		
CV	0.0501	0.0376		
90% CI	13,647	7,465		
Lower	152,589	113,461		
Upper	179,884	128,391		
Sockeye				
Escapement	90,040	58,330	-31,710	-35.2%
Total Var	34,369,768	9,694,898		
SE	5,863	3,114		
CV	0.0651	0.0534		
90% CI	9,615	5,106		
Lower	80,425	53,224		
Upper	99,655	63,437		
Chinook				
Escapement	15,039	21,186	6,147	40.9%
Total Var	4,985,810	1,569,957		
SE	2,233	1,253		
CV	0.1485	0.0591		
90% CI	3,662	2,055		
Lower	11,377	19,131		
Upper	18,701	23,241		
Chum				
Escapement	61,157	41,409	-19,748	-32.3%
Total Var	29,891,826	9,456,230		
SE	5,467	3,075		
CV	0.0894	0.0743		
90% CI	8,966	5,043		
Lower	52,191	36,366		
Upper	70,124	46,452		

Appendix C9.—DIDSON and Bendix escapement estimates for the left bank nearshore stratum (NS) and offshore stratum (OS) by species, Nushagak River sonar project, 26 June–19 July, 2003.

Total	DIDSON NS	Bendix NS	Difference	Percent Deviation	DIDSON OS	Bendix OS	Difference	Percent Deviation
Escapement	152,574	98,189	-54,385	-35.6%	13,663	22,737	9,074	66.4%
Total Var	68,679,827	20,365,299			567,577	355,786		
SE	8,287	4,513			753	596		
CV	0.0543	0.0460			0.0331	0.0437		
90% CI	13,591	7,401			1,236	978		
Lower	138,982	90,788			12,427	21,759		
Upper	166,165	105,590			14,898	23,715		
Sockeye								
Escapement	89,045	56,838	-32,207	-36.2%	995	1,492	497	50.0%
Total Var	34,326,913	9,636,548			42,854	58,350		
SE	5,859	3,104			207	242		
CV	0.0658	0.0546			0.2081	0.1619		
90% CI	9,609	5,091			340	396		
Lower	79,437	51,747			655	1,096		
Upper	98,654	61,929			1,334	1,888		
Chinook								
Escapement	5,112	3,955	-1,158	-22.6%	9,927	17,231	7,305	73.6%
Total Var	4,561,319	1,403,607			424,491	166,349		
SE	2,136	1,185			652	408		
CV	0.4178	0.2996			0.0656	0.0237		
90% CI	3,503	1,943			1,069	669		
Lower	1,610	2,012			8,858	16,562		
Upper	8,615	5,898			10,995	17,900		
Chum								
Escapement	58,416	37,396	-21,020	-36.0%	2,741	4,013	1,272	46.4%
Total Var	29,791,594	9,325,144			100,231	131,087		
SE	5,458	3,054			317	362		
CV	0.0934	0.0817			0.1155	0.0902		
90% CI	8,951	5,008			519	594		
Lower	49,465	32,388			2,222	3,420		
Upper	67,368	42,404			3,260	4,607		

Appendix C10.—DIDSON and Bendix left bank total paired daily counts, Nushagak River sonar project, 12 June–7 August, 2004.

Date	DIDSON		Bendix	
	Daily Total		Daily Total	Difference
6/12	1,599		537	-1,093
6/13	3,252		1,577	-1,653
6/14	216		212	66
6/15	1,467		491	-976
6/16	2,360		862	-1,605
6/17	27,383		3,630	-23,753
6/18	7,126		2,249	-4,877
6/19	38,000		31,993	-6,007
6/20	43,122		43,454	332
6/21	20,673		22,866	2,193
6/22	11,991		12,457	466
6/23	18,374		21,392	3,018
6/24	34,514		36,881	2,367
6/25	17,113		16,450	-663
6/26	10,646		8,918	-1,728
6/27	5,128		5,168	40
6/28	2,403		3,850	1,447
6/29	4,992		4,643	-349
6/30	16,059		10,604	-5,455
7/01	18,493		12,636	-5,857
7/02	3,020		5,000	1,980
7/03	1,500		3,989	2,489
7/04	2,604		5,856	3,252
7/05	6,444		9,195	2,751
7/06	10,080		13,195	3,115
7/07	9,327		10,681	2,213
7/08	3,738		1,618	-1,829
7/09	1,275		417	-805
7/16	986		780	-210
7/17	1,227		1,351	124
7/18	943		998	55
7/19	448		667	244
7/20	332		480	168
7/21	514		740	226
7/22	429		799	370
7/23	405		814	409
7/24	1,468		1,494	26
7/25	3,455		2,275	-1,180
7/26	3,013		2,457	-556
7/27	2,296		1,475	-821
7/28	1,893		1,836	-57
7/29	3,603		3,385	-218
7/30	3,779		5,667	1,888
7/31	11,261		11,978	717
8/01	17,452		16,982	-470
8/02	21,189		11,538	-9,651
8/03	8,489		6,684	-1,805
8/04	8,480		5,592	-2,888
8/05	5,643		4,043	-1,598
8/06	6,629		4,477	-2,152
8/07	48,655		32,542	-16,113
Total	475,486		409,875	-65,611
				-13.8%

Appendix C11.—DIDSON and Bendix left bank inshore stratum paired daily counts, Nushagak River sonar project, 12 June–7 August, 2004.

Date	DIDSON		Bendix		Percent Deviation
	Nearshore		Nearshore	Difference	
6/12	1,599		537	-1,062	
6/13	3,252		1,577	-1,675	
6/14	216		212	-4	
6/15	1,467		491	-976	
6/16	2,360		862	-1,498	
6/17	19,377		2,721	-16,656	
6/18	4,657		1,424	-3,233	
6/19	32,046		30,354	-1,692	
6/20	33,604		41,248	7,644	
6/21	16,188		21,570	5,382	
6/22	8,481		11,675	3,194	
6/23	14,083		20,277	6,194	
6/24	24,919		34,137	9,218	
6/25	13,743		15,582	1,839	
6/26	6,567		8,036	1,469	
6/27	2,576		4,573	1,997	
6/28	1,470		3,582	2,112	
6/29	3,957		4,316	359	
6/30	12,244		9,004	-3,240	
7/01	15,433		10,554	-4,879	
7/02	1,790		4,290	2,500	
7/03	810		3,498	2,688	
7/04	2,054		5,434	3,380	
7/05	5,118		8,232	3,114	
7/06	7,978		11,465	3,487	
7/07	7,526		9,036	1,510	
7/08	3,247		1,428	-1,819	
7/09	1,081		328	-753	
7/16	804		747	-57	
7/17	930		1,260	330	
7/18	689		871	182	
7/19	230		541	311	
7/20	272		455	183	
7/21	429		668	239	
7/22	374		773	399	
7/23	302		761	459	
7/24	1,244		1,420	176	
7/25	2,832		2,133	-699	
7/26	2,481		2,293	-188	
7/27	1,788		1,343	-445	
7/28	985		1,616	631	
7/29	2,356		3,058	702	
7/30	2,587		5,395	2,808	
7/31	9,014		11,458	2,444	
8/01	15,582		16,761	1,179	
8/02	19,646		11,472	-8,174	
8/03	6,890		6,601	-289	
8/04	7,536		5,525	-2,011	
8/05	4,608		3,958	-650	
8/06	5,485		4,392	-1,093	
8/07	46,949		32,313	-14,636	
Total	381,859		382,257	398	0.1%

Appendix C12.—DIDSON and Bendix left bank offshore stratum paired daily counts, Nushagak River sonar project, 17 June–8 August, 2004.

Date	DIDSON		Bendix	Percent Deviation
	Offshore	Offshore	Offshore	
6/17	8,005		909	-7,096
6/18	2,469		825	-1,644
6/19	5,954		1,639	-4,315
6/20	9,517		2,206	-7,311
6/21	4,485		1,296	-3,189
6/22	3,510		782	-2,728
6/23	4,291		1,115	-3,176
6/24	9,596		2,744	-6,852
6/25	3,370		868	-2,502
6/26	4,079		882	-3,197
6/27	2,552		595	-1,957
6/28	933		268	-665
6/29	1,035		327	-708
6/30	3,815		1,600	-2,215
7/01	3,060		2,082	-978
7/02	1,230		710	-520
7/03	690		491	-199
7/04	551		422	-129
7/05	1,326		963	-363
7/06	2,101		1,730	-371
7/07	1,801		1,645	-156
7/08	490		190	-300
7/09	194		89	-105
7/16	182		33	-149
7/17	296		91	-205
7/18	254		127	-127
7/19	218		126	-92
7/20	61		25	-36
7/21	85		72	-13
7/22	54		26	-28
7/23	103		53	-50
7/24	224		74	-150
7/25	623		142	-481
7/26	532		164	-368
7/27	508		132	-376
7/28	908		220	-688
7/29	1,247		327	-920
7/30	1,192		272	-920
7/31	2,247		520	-1,727
8/01	1,870		221	-1,649
8/02	1,543		66	-1,477
8/03	1,599		83	-1,516
8/04	944		67	-877
8/05	1,035		85	-950
8/06	1,144		85	-1,059
8/07	1,706		229	-1,477
Total	93,627		27,618	-66,009
				-70.5%

Appendix C13.—DIDSON left bank inshore stratum daily hourly counts, Nushagak River sonar project, 12 June–7 August, 2004.

Hour	Date											Total
	6/12	6/13	6/14	6/15	6/16	6/17	6/18	6/19	6/20	6/21	6/22	
100		24		42	60	139	471	97	3,733	1,546	448	6,560
200		108		48	54	42	689	302	1,613	966	278	4,100
300		132		36	198	187	230	133	695	761	175	2,547
400		180		30	30	103	109	91	399	477	163	1,581
500		168		397	84	157	103	18	447	290	91	1,754
600		427		60	96	423	97	48	930	254	121	2,455
700		349		282	120	797	290	42	1,999	821	139	4,841
800		144		108	96	1,854	211	139	1,389	858	175	4,975
900		313		30	180	3,582	489	248	761	447	133	6,183
1000				12	36	556	91	320	748	767	248	2,778
1100				6	18	1,395	205	490	1,410	737	659	4,921
1200		67		24	12	254	435	254	345	1,202	3,008	5,601
1300		90		6	6	2,301	127	442	2,845	605	747	7,169
1400	240	156		30	6	695	85	127	1,504	1,462	97	4,402
1500	210	114		36	69	876	24	647	4,029	828	54	6,888
1600	216	180	36	0	42	610	30	1,755	1,879	640	815	6,204
1700	427	198	18	0	6	387	42	2,856	1,818	169	411	6,332
1800	150	120	36	36	60	79	151	5,712	888	387	18	7,636
1900	24	48	6	48	90	1,033	48	85	327	248	0	1,957
2000	102	90	30	36	301	1,274	121	1,003	350	230	30	3,567
2100		30	42	91	415	821	60	3,123	677	713	54	6,027
2200	102	313	36	-6	240	846	230	3,811	1,601	1,291	230	8,693
2300	108		-12	18	79	628	187	5,213	1,287	206	320	8,034
2400	18		24	96	60	338	133	5,092	1,933	284	66	8,045

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Hour	Date											Total
	6/23	6/24	6/25	6/26	6/27	6/28	6/29	6/30	7/1	7/2	7/3	
100	36	2,898	423	217	145	54	73	1,216	1,045	61	42	6,211
200	30	2,535	575	230	54	6	42	852	877	6	18	5,226
300	97	962	381	369	194	79	12	519	1,250	0	36	3,899
400	60	175	284	320	169	24	0	966	1,009	18	6	3,032
500	24	163	30	362	175	0	0	756	968	24	73	2,576
600	48	315	187	260	24	48	18	272	1,452	12	42	2,679
700	12	1,139	640	320	248	236	18	48	157	30	0	2,850
800	12	2,410	1,353	163	72	176	30	42	356	24	0	4,640
900	55	870	460	54	85	133	18	308	97	30	18	2,128
1000	18	616	182	212	115	109	12	97	115	538	-24	1,990
1100	54	933	242	297	145	48	12	36	18	12	6	1,805
1200	381	697	1,095	339	175	157	42	296	127	24	6	3,340
1300	509	3,334	797	647	254	133	290	362	538	24	12	6,901
1400	206	605	803	308	12	67	18	327	399	-6	0	2,739
1500	91	1,422	1,210	320	103	66	997	1,386	870	12	0	6,476
1600	163	1,406	2,030	217	67	48	411	1,389	1,057	157	24	6,969
1700	85	888	582	532	175	18	42	405	1,501	242	0	4,470
1800	30	703	497	175	18	6	127	326	750	36	12	2,681
1900	562	219	200	30	79	12	24	85	6	91	60	1,367
2000	109	121	424	42	18	-6	85	701	1,192	278	6	2,969
2100	290	532	628	278	97	12	296	532	497	79	199	3,439
2200	592	1,045	242	109	30	0	701	236	593	66	103	3,716
2300	5,068	338	139	327	79	0	199	163	157	18	72	6,561
2400	5,551	593	339	436	42	42	489	924	400	12	97	8,926

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Hour	Date											Total
	7/4	7/5	7/6	7/7	7/8	7/9	7/16	7/17	7/18	7/19	7/20	
100	54	139	230	924			133	18	-6	-6		1,486
200	79	163	248	278			54	54	12	18		907
300	60	121	151	296			12	36	6	6		689
400	54	169	557	586			61	6	30	48		1,511
500	193	223	526				48	42	36	12		1,082
600	0	338	303				60	18	42	24		786
700	139	242	781				30	24	48	36		1,300
800	103	628	472				-30	0	36	24		1,233
900	42	344	557				24	42	60	-6		1,064
1000	24	18	557				6	60	42	0	0	708
1100	48	18	18	1,842		332	6	91	79	0	97	2,531
1200	-18	85	18	157	1,392	115	-6	-18	0	6	-12	1,718
1300	6	36	109	127	12	393		24	0	-6	-6	695
1400	24	66	103	308	381	66		0	6	6	18	979
1500	36	97	91	85	435	24	-6	12	6	12	6	798
1600	12	42	617	900	109	85	109	0	12	6	0	1,892
1700	30	91	109	646	200	66	85	91	24	0	6	1,348
1800	60	60	36	279	55	0	6	12	0	48	42	599
1900	278	169	79	103	12		18	66	30	0	36	792
2000	79	883	368	256	42		79	72	85	0	24	1,888
2100	230	604	677		610		103	157	12	0	0	2,392
2200	66	248	211	739			6	109	12	0	42	1,434
2300	139	242	321				6	24	66	6	0	804
2400	314	91	841				0	-12	48		12	1,294

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Hour	Date											Total
	7/21	7/22	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30	7/31	
100	-6	12	6	6	36	48	18	18	30	67	187	423
200	6	18	0	30	36	30	-6	42	67	79	121	424
300	6	24	0	36	79	6	6	6	42	507	315	1,028
400	18	0	12	24	24	-6	6	66	48	471	362	1,027
500	18	6	18	30	48	6	6	-12	103	200	163	586
600	30	48	0	6	42	6	0	-18	36	91	640	882
700	24	54	18	12	18	12	42	36	12	24	200	453
800	60	0	6	18	30	18	30	18	79	73	66	399
900	12	-12	0	12	145	36	6	0	85	18	103	405
1000	30	0	18	0	508	169	12	12	85	6	157	998
1100	24	42	0	12	811	998	803	30	163	85	79	3,048
1200	24	0	6	187	218	103	169	72	157	18	103	1,058
1300	12	18	6	175	61	115	260	109	169	0	103	1,027
1400	0	12	0	6	24	30	109	79	157	18	36	471
1500	0	-6	18	48	85	109	24	157	205	139	629	1,409
1600	6	6	-6	12	0	109	36	66	91	67	2,326	2,713
1700	0	-6	12	36	54	73	36	36	169	97	3,043	3,551
1800	-12	0	24	48	18	145	133	0	441	139	278	1,214
1900	24	97	6	6	42	315	60	12	133	217	42	955
2000	6	42	0	12	303	73	0	48	18	30	24	556
2100	12	6	66	-6	175	48	0	12	24	79	18	435
2200	12	-6	0	79	6	24	0	175	6	48	6	350
2300	36	18	36	30	67	12	30	18	18	67	6	339
2400	85	0	54	423	0	0	6	0	18	48	6	640

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Hour	Date							Total
	8/1	8/2	8/3	8/4	8/5	8/6	8/7	
100	296	296	139	91	48	60	459	1,389
200	399	834	417	121	79	115	465	2,430
300	526	870	363	103	54	248	483	2,647
400	321	1,105	532	42	66	85	417	2,568
500	460	864	876	54	24	48	139	2,465
600	726	950	678	115	36	60	115	2,680
700	163	12	6	139	0	54	60	436
800	48	254	0	66	48	42	42	502
900	6	-12	375	678	163	1,045	30	2,285
1000	72	6	18	6	490	803	2,211	3,607
1100	1,086	127	18	6	302	900	2,662	5,101
1200	91	181	66	73	139	6	6,091	6,647
1300	164	236	48	707	635	139	6,801	8,730
1400	339	514	622	145	315	453	2,326	4,714
1500	157	115	54	6	405	417	580	1,734
1600	726	266	0	532	18	6	145	1,693
1700	2,954	1,785	67	610	0	223	145	5,784
1800	332	1,202	368	224	266	115	1,585	4,092
1900	4,168	4,943	556	1,208	6	139	2,168	13,188
2000	2,332	4,234	61	2,144	569	91	1,951	11,381
2100	18	557	791	139	672	0	5,201	7,377
2200	145	223	761	103	139	6	6,886	8,263
2300	54	73	6	223	67	338	4,814	5,575
2400	0	12	67	0	66	91	1,172	1,408

Appendix C14.—Bendix left bank inshore stratum daily hourly counts, Nushagak River sonar project, 12 June–7 August, 2004.

Hour	Date											Total
	6/12	6/13	6/14	6/15	6/16	6/17	6/18	6/19	6/20	6/21	6/22	
100		21		12	41	47	36	91	4,058	1,593	425	6,324
200		36		11	37	45	34	90	1,852	1,476	544	4,125
300		78		22	53	49	48	64	964	1,377	333	2,988
400		63		23	36	81	67	33	737	722	265	2,027
500		89		24	50	73	33	51	892	574	219	2,005
600		68		17	54	120	68	84	1,471	990	224	3,096
700		109		26	59	83	104	85	1,843	1,125	297	3,731
800		125		23	58	77	50	70	1,321	837	410	2,971
900		96		28	52	105	72	36	1,238	451	301	2,379
1000				12	65	92	42	100	2,192	1,406	337	4,246
1100				24	60	135	115	148	2,095	1,144	1,332	5,053
1200		54		18	25	163	126	186	3,867	1,681	2,100	8,220
1300		33		11	8	264	29	295	1,868	1,911	724	5,143
1400	30	39		24	10	253	40	231	2,558	1,076	397	4,658
1500	33	31		15	14	164	50	412	3,241	1,048	814	5,822
1600	98	67	68	11	12	35	45	2,230	2,162	495	554	5,777
1700	76	57	67	18	23	22	58	2,505	1,197	264	317	4,604
1800	59	34	41	7	37	23	29	4,387	624	247	213	5,701
1900	76	144	10	10	28	291	27	1,235	245	435	104	2,605
2000	77	114	2	22	23	183	34	1,416	480	699	166	3,216
2100		134	2	27	28	157	96	2,716	1,661	687	512	6,020
2200	28	185	4	60	25	131	82	4,634	1,365	590	458	7,562
2300	29		13	19	34	75	92	3,933	1,369	339	344	6,247
2400	31		5	27	30	53	47	5,322	1,948	403	285	8,151

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Hour	Date											Total
	6/23	6/24	6/25	6/26	6/27	6/28	6/29	6/30	7/1	7/2	7/3	
100	292	3,139	1,073	494	152	224	61	503	580	310	125	6,953
200	252	2,636	778	681	194	215	56	517	523	214	130	6,196
300	240	1,092	586	465	184	174	36	603	616	225	162	4,383
400	276	719	596	645	266	198	33	711	802	204	176	4,626
500	238	637	310	466	289	176	106	378	526	197	170	3,493
600	234	889	646	594	361	284	140	278	239	192	173	4,030
700	254	2,386	1,537	650	420	317	166	325	299	202	180	6,736
800	291	3,311	871	361	306	306	170	258	415	254	187	6,730
900	267	1,026	378	280	286	237	185	358	228	247	180	3,672
1000	204	595	431	259	210	219	104	210	320	403	152	3,107
1100	449	1,223	597	383	237	268	31	177	185	154	168	3,872
1200	626	2,860	773	362	289	184	93	218	228	136	123	5,892
1300	618	2,959	919	384	113	114	405	412	489	111	123	6,647
1400	297	1,755	562	419	54	76	154	494	369	63	90	4,333
1500	182	2,214	783	276	114	56	471	569	616	124	103	5,508
1600	321	1,179	1,498	249	83	74	136	610	689	126	111	5,076
1700	275	1,308	570	172	142	58	161	271	497	106	118	3,678
1800	393	737	367	86	76	50	180	136	512	61	124	2,722
1900	337	436	246	69	170	50	120	141	793	184	91	2,637
2000	517	292	582	119	50	37	208	323	370	237	142	2,877
2100	976	584	624	200	110	46	252	236	198	170	200	3,596
2200	4,127	1,020	226	109	145	55	247	230	458	123	131	6,871
2300	4,926	637	175	150	176	64	289	426	318	134	141	7,436
2400	3,685	503	454	163	146	100	512	620	284	113	198	6,778

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Hour	Date										Total
	7/4	7/5	7/6	7/7	7/8	7/9	7/16	7/17	7/18	7/19	
100	247	294	489	736			46	29	39	26	1,906
200	250	405	625	843			41	63	51	29	2,307
300	273	319	625	1,010			59	39	56	33	2,414
400	353	404	845	1,042			23	66	29	20	2,782
500	320	499	648				29	40	34	10	1,580
600	307	505	823				25	31	37	52	1,780
700	313	624	851				47	14	56	37	1,942
800	290	526	675				26	27	52	26	1,622
900	275	240	685				21	53	27	20	1,321
1000	258	236	312				26	44	13	11	925
1100	294	278	269	196		50	19	34	38	17	1,213
1200	122	217	273	209	152	53	11	42	10	8	1,113
1300	126	259	218	622	164	75		35	21	20	15
1400	86	264	158	417	320	13		3	19	58	30
1500	75	246	232	535	191	27	49	12	45	5	27
1600	119	179	272	840	102	59	51	23	21	35	41
1700	144	170	130	568	126	42	23	78	33	16	38
1800	138	158	81	208	40	9	29	81	14	49	41
1900	264	326	80	172	47		13	135	36	10	34
2000	219	514	489	750	171		68	104	35	32	22
2100	184	334	504		115		40	111	7	15	23
2200	242	300	552	888			21	66	35	12	46
2300	250	449	678				24	81	86		55
2400	285	486	951				56	49	77		1,928

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Hour	Date											Total
	7/21	7/22	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30	7/31	
100	25	37	18	34	57	82	60	42	103	142	311	911
200	26	30	31	69	53	27	18	46	152	403	789	1,644
300	16	50	21	44	101	24	37	77	242	917	866	2,395
400	20	32	28	18	102	8	6	30	200	886	588	1,918
500	13	9	21	181	34	7	31	12	202	328	733	1,571
600	31	25	18	29	34	45	43	35	105	159	626	1,150
700	22	28	27	54	25	20	46	31	108	133	154	648
800	24	49	38	45	52	26	61	35	117	121	188	756
900	28	21	47	22	97	54	27	12	84	95	136	623
1000	24	10	22	54	202	120	77	58	59	43	97	766
1100	20	23	25	21	247	337	228	83	86	126	144	1,340
1200	40	21	12	65	164	429	108	125	174	142	151	1,431
1300	19	15	28	77	38	66	125	53	139	107	96	763
1400	20	29	24	24	122	142	63	88	169	170	204	1,055
1500	8	2	27	26	90	83	31	223	134	160	895	1,679
1600	19	51	31	12	48	117	134	78	211	330	2,226	3,257
1700	38	27	14	30	51	114	48	90	128	288	1,980	2,808
1800	15	50	21	94	66	120	65	84	178	192	584	1,469
1900	48	79	90	78	106	103	32	49	163	334	324	1,406
2000	31	24	10	77	209	78	14	70	41	44	35	633
2100	16	15	36	32	72	91	8	71	52	62	60	515
2200	65	25	51	52	51	79	34	79	55	57	31	579
2300	29	86	67	87	65	90	24	48	34	46	63	639
2400	71	35	54	195	47	31	23	97	122	110	177	962

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Hour	Date							Total
	8/1	8/2	8/3	8/4	8/5	8/6	8/7	
100	396	691	280	92	50	134	742	2,385
200	617	807	349	137	65	286	500	2,761
300	550	754	371	86	21	149	369	2,300
400	377	942	847	37	30	110	216	2,559
500	612	636	654	63	21	65	187	2,238
600	330	341	253	119	17	67	62	1,189
700	43	53	52	32	46	21	44	291
800	62	61	103	108	112	145	39	630
900	95	14	297	163	123	395	68	1,155
1000	156	56	29	138	233	361	1,749	2,722
1100	732	234	70	48	20	431	2,307	3,842
1200	414	299	89	88	436	55	1,238	2,619
1300	298	325	114	634	287	201	3,481	5,340
1400	351	178	277	55	354	385	1,222	2,822
1500	670	274	115	63	121	168	213	1,624
1600	1,803	792	42	226	25	93	78	3,059
1700	2,394	676	207	312	260	192	378	4,419
1800	2,620	704	482	507	131	96	1,417	5,957
1900	2,974	2,058	688	923	286	369	1,629	8,927
2000	469	1,181	166	1,379	345	92	3,747	7,379
2100	369	170	770	169	489	34	4,313	6,314
2200	175	84	192	89	386	117	5,496	6,539
2300	134	81	93	38	48	235	2,411	3,040
2400	120	61	61	19	52	191	407	911

Appendix C15.—DIDSON left bank offshore stratum daily hourly counts, Nushagak River sonar project, 17 June–7 August, 2004.

Hour	Date										Total	
	6/17	6/18	6/19	6/20	6/21	6/22	6/23	6/24	6/25	6/26		
100	48	200	67	793	296	163	248	612	309	188	79	3,003
200	109	169	97	248	206	188	85	376	73	54	109	1,713
300	54	139	48	405	194	67	79	418	61	97	103	1,665
400	218	103	30	351	42	36	48	297	49	12	55	1,242
500	254	36	67	405	145	42	54	188	12	79	97	1,380
600	526	284	139	617	169	157	48	624	176	170	127	3,040
700	526	212	133	532	121	115	24	375	109	158	55	2,361
800	800	188	139	357	127	36	79	273	97	79	97	2,271
900	460	230	230	865	175	79	42	364	79	48	73	2,645
1000	224	67	42	653	1,004	175	61	303	61	103	24	2,717
1100	279	67	67	448	266	460	388	498	85	219	79	2,854
1200	235	42	42	230	267	315	0	990	169	285	127	2,702
1300	732	73	345	345	85	151	42	1,038	315	255	188	3,568
1400	575	91	284	206	67	109	36	462	127	48	182	2,188
1500	206	67	109	641	224	248	97	194	333	67	212	2,398
1600	284	36	744	309	127	164	151	284	158	388	146	2,791
1700	200	42	103	484	97	73	61	750	182	164	109	2,265
1800	315	79	726	127	145	103	163	339	97	67	73	2,233
1900	327	42	569	254	61	0	85	260	0	436	109	2,142
2000	309	91	212	212	67	278	194	158	291	255	261	2,325
2100	296	73	278	478	164	236	309	97	370	266	73	2,639
2200	230	54	430	206	225	188	254	212	85	334	103	2,320
2300	405	36	587	206	103	54	1,023	188	79	169	42	2,892
2400	393	48	466	145	109	73	720	297	55	139	30	2,475

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Hour	Date											Total
	6/28	6/29	6/30	7/1	7/2	7/3	7/4	7/5	7/6	7/7	7/8	
100	36	30	79	79	49	61	12	91	145	176		757
200	79	6	182	109	18	42	0	24	61	121		642
300	48	12	157	85	30	54	18	24	30	91		551
400	6	24	224	79	24	30	24	30	73	139		654
500	12	36	188	248	49	36	6	18	42	55		690
600	48	24	194	327	139	24	30	61	30			878
700	48	18	218	200	206	152	30	55	36			964
800	6	12	139	151	42	30	36	73	42			533
900	6	24	139	97	85	0	73	67	18			508
1000	79	12	97	224	-18	0	-18	151	103			630
1100	36	18	30	133	109	18	133	24	127	30	12	672
1200	55	36	290	170	0	36	-12	54	73	127	91	920
1300	24	-55	91	6	18	18	6	42	103	12	18	285
1400	49	36	85	12	6	12	0	30	67	48	85	430
1500	169	67	30	36	48	-18	12	79	103	272	36	835
1600	73	109	394	67	48	30	30	0	127	272	36	1,187
1700	-6	67	267	152	61	36	12	24	36	121	73	842
1800	18	103	207	206	48	30	30	18	48	109	36	855
1900	-6	54	183	164	48	24	-18	200	55	42	48	795
2000	18	91	24	170	12	18	12	36	140	8	36	566
2100	24	91	248	61	73	24	48	54	254	127	18	1,023
2200	48	42	103	146	24	12	24	-6	60	48		503
2300	24	127	169	61	36	-6	24	85	115			636
2400	36	48	79	79	73	24	36	91	212			678

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Hour	Date											Total
	7/9	7/16	7/17	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	
100		-6	24	0	0		0	0	0	0	12	30
200		12	12	12	0		0	18	0	18	48	121
300		30	0	12	18		6	0	6	6	48	127
400		0	0	6	12		0	-6	0	0	12	24
500		6	6	24	0		6	6	12	0	-6	54
600		-6	-6	6	18		0	-6	0	12	6	24
700		24	6	30	24		0	12	-6	12	6	109
800		-18	12	61	36		30	0	0	42	18	182
900		0	48	6	42		6	6	0	0	6	115
1000	18	12	36	0	-6	12	6	6	6	0	6	97
1100	18	6	12	54	6	-6	0	0	48	18	6	163
1200	42	6	18	12	-18	-6	18	24	6	61	163	327
1300	24		6	-6	0	6	0	-6	0	6	67	97
1400	12		6	-6	-18	-6	0	0	-6	-6	30	6
1500	30	6	12	6	30	0	-12	-6	6	6	0	79
1600	-18	12	6	24	0	12	6	-6	0	0	67	103
1700	67	30	-6	18	12	6	0	6	6	-6	12	145
1800	12	18	6	24	0	6	0	6	6	6	12	91
1900	0	6	6	24	12	12	0	6	6	24	12	103
2000	12	24	-6		0	0	18	0	-6	18	61	
2100	-6	18	0	12	0	0	6	0	6	6	12	48
2200	6	6	12		12	0	-6	6	6	6	24	67
2300	24	24	6		6	0	-12	0	6	0	0	54
2400	18	6	-30		12	0	0	6	12	42	67	

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Hour	Date										Total	
	7/26	7/27	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4		
100	6	12	12	61	30	18	42	133	175	12	48	551
200	12	6	18	24	36	109	97	163	236	36	6	744
300	6	0	54	24	206	67	169	151	309	18	18	1,023
400	0	0	42	67	151	163	145	182	255	24	12	1,041
500	0	0	-6	79	248	169	85	139	109	36	12	871
600	0	48	-6	121	109	933	109	79	36	97	24	1,551
700	24	18	30	157	91	412	67	6	12	0	0	818
800	12	0	30	103	30	61	18	42	36	0	24	357
900	6	6	67	42	6	6	36	6	24	157	-12	345
1000	42	42	24	24	18	6	115	0	6	79	151	508
1100	6	24	24	24	42	18	54	67	24	0	36	321
1200	30	36	18	6	61	0	61	61	0	85	18	375
1300	36	61	36	12	6	18	0	127	61	218	103	678
1400	145	6	12	18	42	36	18	36	12	6	6	339
1500	12	73	230	91	36	55	36	0	18	42	61	654
1600	67	0	79	188	6	12	0	85	0	18	0	454
1700	42	12	36	24	18	61	12	54	85	6	73	424
1800	18	121	61	30	36	18	115	30	91	0	0	520
1900	12	6	30	30	12	54	73	18	36	24	6	303
2000	-12	12	18	6	6	18	18	103	42	-6	48	254
2100	6	0	0	6	6	0	575	0	6	36	248	883
2200	6	30	0	61	6	0	0	54	12	12		182
2300	54	0	6	12	0	-6	6	6	12	42	103	236
2400	0	-6	91	36	-12	18	18	0	0	0	48	194

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Hour	Date		
	8/6	8/7	Total
100	42	284	327
200	79	127	206
300	54	188	242
400	24	121	145
500	42	115	157
600	42	67	109
700	18	6	24
800	30	0	30
900	42	0	42
1000	12	24	36
1100	266	6	272
1200	133	30	164
1300	6	387	393
1400	12	157	169
1500	-6	42	36
1600	36	6	42
1700	12	48	61
1800	224	6	230
1900	-6	12	6
2000	-12	6	-6
2100	6	0	6
2200	36	48	85
2300	12	6	18
2400	36	18	54

Appendix C16.—Bendix left bank offshore stratum daily hourly counts, Nushagak River sonar project, 17 June–7 August, 2004.

Hour	Date										Total	
	6/17	6/18	6/19	6/20	6/21	6/22	6/23	6/24	6/25	6/26		
100	9	22	46	274	121	69	51	227	71	23	29	942
200	33	15	16	116	73	33	19	179	39	17	30	570
300	13	17	5	118	64	18	25	115	16	26	21	438
400	27	35	10	100	37	9	12	172	23	32	30	487
500	21	57	23	218	53	25	2	213	18	23	52	705
600	24	43	43	107	73	26	10	241	61	63	38	729
700	56	52	29	99	44	42	20	90	31	25	22	510
800	67	150	100	73	27	6	7	69	29	8	13	549
900	31	165	193	318	69	17	15	72	24	10	33	947
1000	26	12	37	141	233	70	31	88	16	14	38	706
1100	26	15	39	59	79	76	95	133	15	40	21	598
1200	15	20	15	43	39	42	19	363	67	23	35	681
1300	35	2	116	57	28	53	2	218	79	53	11	654
1400	45	23	41	65	24	28	12	95	40	33	3	409
1500	34	16	58	91	35	24	4	48	52	40	8	410
1600	44	29	65	30	71	14	16	56	30	77	5	437
1700	31	27	52	70	17	25	14	77	39	46	2	400
1800	19	17	143	44	17	28	31	33	16	74	5	427
1900	56	7	144	27	23	13	21	53	37	24	31	436
2000	62	14	68	48	39	22	30	14	29	48	21	395
2100	46	27	50	37	26	82	73	27	52	86	30	536
2200	48	13	91	16	28	20	156	53	29	38	39	531
2300	74	25	134	25	29	18	181	54	28	29	29	626
2400	67	22	121	30	47	22	269	54	27	30	49	738

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Hour	Date											Total
	6/28	6/29	6/30	7/1	7/2	7/3	7/4	7/5	7/6	7/7	7/8	
100	26	3	73	73	35	33	9	68	114	186		620
200	12	4	71	148	21	26	6	39	50	219		596
300	10	8	120	72	24	25	9	25	28	88		409
400	8	20	165	117	33	11	16	19	107	266		762
500	15	10	86	190	14	32	44	25	25	152		593
600	10	1	75	177	66	51	29	19	45			473
700	24	15	165	154	49	46	22	71	30			576
800	10	1	87	165	69	17	36	13	36			434
900	10	19	50	77	49	88	25	33	39			390
1000	15	5	32	42	53	12	45	18	36			258
1100	10	1	17	45	16	13	6	24	73	11	23	239
1200	4	7	70	89	19	48	7	47	95	86	20	492
1300	9	21	22	35	12	22	19	32	89	17	24	302
1400	4	15	37	22	15	5	14	9	31	21	30	203
1500	23	18	50	26	13	2	1	55	51	131	10	380
1600	6	10	118	60	11	3	14	15	89	123	16	465
1700	7	18	67	83	20	5	16	52	43	49	19	379
1800	0	27	30	141	9	10	2	25	35	44	21	344
1900	13	21	40	63	22	11	5	28	70	48	10	331
2000	11	26	32	81	35	8	4	59	72	17	4	349
2100	12	22	53	41	25	11	25	46	108	104	13	460
2200	17	9	35	75	20	4	13	50	128	83		434
2300	9	36	54	58	30	4	24	116	105			436
2400	3	10	51	48	50	4	31	75	231			503

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Hour	Date											Total
	7/9	7/16	7/17	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	
100		7	0	2	3		2	0	3	3	2	22
200		0	0	1	4		10	0	1	0	16	32
300		3	1	3	0		3	0	0	0	3	13
400		8	0	0	0		0	3	0	0	4	15
500		3	1	5	1		2	0	2	1	2	17
600		1	3	3	5		2	1	4	3	7	29
700		4	8	13	9		4	0	18	4	6	66
800		0	11	25	10		4	3	1	0	7	61
900		0	10	13	13		4	3	4	2	2	51
1000	9	0	18	25	30	4	13	1	0	0	0	100
1100	3	0	3	11	2	5	7	4	14	4	6	59
1200	18	0	16	0	2	2	17	1	0	4	13	73
1300	27		4	0	5	0	1	2	2	6	0	47
1400	2		2	2	1	1	0	0	0	4	13	25
1500	23	0	0	0	2	3	0	0	0	6	8	42
1600	3	0	0	0	3	6	0	0	1	4	5	22
1700	4	2	0	0	13	0	0	1	0	14	2	36
1800	0	1	2	20	0	2	2	0	0	4	4	35
1900	1	2	2	3	0	0	0	1	0	0	3	12
2000	1	1	1		0	0	0	0	0	4	18	25
2100	1	6	8	0	1	0	3	0	0	1	13	33
2200	0	0	5		0	0	1	0	0	0	2	8
2300	0	3	2		3	0	1	0	0	3	5	17
2400	2	1	4		0	1	0	2	7	1	18	

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Hour	Date										Total	
	7/26	7/27	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4		
100	2	29	2	3	1	3	6	3	3	2	0	54
200	3	1	1	2	10	11	13	3	10	3	3	60
300	2	1	21	14	24	17	57	6	12	10	5	169
400	3	10	1	20	45	42	6	5	8	9	0	149
500	4	0	10	10	50	50	8	3	5	3	2	145
600	1	0	5	70	30	177	16	4	3	2	3	311
700	11	10	8	52	18	81	22	4	2	0	0	208
800	16	1	30	28	10	22	1	7	4	3	1	123
900	22	3	31	14	21	8	12	4	4	7	5	131
1000	3	3	2	15	4	8	9	6	0	6	34	90
1100	8	2	5	2	14	7	14	4	6	3	4	69
1200	5	5	9	3	1	11	11	3	4	1	3	56
1300	6	5	3	5	5	2	3	1	2	9	8	49
1400	6	13	11	5	4	6	6	0	0	0	7	58
1500	0	3	15	9	1	1	6	1	3	1	2	42
1600	18	9	7	7	14	0	5	0	2	0	1	63
1700	13	1	7	7	3	1	15	1	2	0	0	50
1800	7	5	2	10	3	53	4	0	3	1	0	88
1900	4	2	8	10	4	10	2	2	0	0	1	43
2000	5	9	2	2	9	3	0	0	1	0	3	34
2100	4	14	28	1	0	0	2	0	3	2	2	56
2200	8	5	1	4	1	4	0	7	6	3		39
2300	13	0	4	32	0	1	0	0	0	1	0	51
2400	0	1	7	2	0	2	3	2	0	1	1	19

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Hour	Date		
	8/6	8/7	Total
100	9	19	28
200	18	26	44
300	4	21	25
400	5	16	21
500	5	22	27
600	3	14	17
700	3	0	3
800	2	10	12
900	5	4	9
1000	3	5	8
1100	5	3	8
1200	2	23	25
1300	3	42	45
1400	4	4	8
1500	2	0	2
1600	2	0	2
1700	2	4	6
1800	0	4	4
1900	0	0	0
2000	0	0	0
2100	0	4	4
2200	0	0	0
2300	0	3	3
2400	8	5	13

Appendix C17.—DIDSON and Bendix total escapement estimates for the left (south) bank by species, Nushagak River sonar project, 12 June–7 August, 2004.

Total	DIDSON	Bendix	Difference	Percent Deviation
Escapement	475,486	409,875	-65,611	-13.8%
Total Var	142,518,478	143,379,327		
SE	11,938	11,974		
CV	0.0251	0.0292		
90% CI	19,579	19,638		
Lower	455,908	390,237		
Upper	495,065	429,513		
Sockeye				
Escapement	136,142	151,934	15,792	11.6%
Total Var	50,433,646	54,783,726		
SE	7,102	7,402		
CV	0.0522	0.0487		
90% CI	11,647	12,139		
Lower	124,495	139,796		
Upper	147,789	164,073		
Chinook				
Escapement	103,911	62,167	-41,745	-40.2%
Total Var	29,232,257	28,163,214		
SE	5,407	5,307		
CV	0.0520	0.0854		
90% CI	8,867	8,703		
Lower	95,044	53,463		
Upper	112,778	70,870		
Chum				
Escapement	98,283	90,452	-7,831	-8.0%
Total Var	40,280,143	43,229,125		
SE	6,347	6,575		
CV	0.0646	0.0727		
90% CI	10,409	10,783		
Lower	87,875	79,670		
Upper	108,692	101,235		
Coho				
Escapement	8,966	6,945	-2,021	-22.5%
Total Var	5,812,557	4,448,401		
SE	2,411	2,109		
CV	0.2689	0.3037		
90% CI	3,954	3,459		
Lower	5,012	3,486		
Upper	12,919	10,404		
Pink				
Escapement	128,184	98,377	-29,807	-23.3%
Total Var	16,759,875	12,754,860		
SE	4,094	3,571		
CV	0.0319	0.0363		
90% CI	6,714	5,857		
Lower	121,470	92,520		
Upper	134,898	104,234		

Appendix C18.—DIDSON and Bendix escapement estimates by species for the left bank nearshore stratum (NS), 12 June–7 August 2004, and offshore stratum (NS), 17 June–7 August, Nushagak River sonar project.

Total	DIDSON NS	Bendix NS	Difference	Percent Deviation	DIDSON OS	Bendix OS	Difference	Percent Deviation
Escapement	381,859	382,257	398	0.1%	93,627	27,618	-66,009	-70.5%
Total Var	132,515,097	142,821,264			10,003,381	558,063		
SE	11,512	11,951			3,163	747		
CV	0.0301	0.0313			0.0338	0.0270		
90% CI	18,879	19,599			5,187	1,225		
Lower	362,980	362,658			88,440	26,393		
Upper	400,738	401,856			98,814	28,843		
Sockeye								
Escapement	129,526	149,757	20,231	15.6%	6,616	2,177	-4,439	-67.1%
Total Var	49,362,120	54,672,186			1,071,526	111,540		
SE	7,026	7,394			1,035	334		
CV	0.0542	0.0494			0.1565	0.1534		
90% CI	11,522	12,126			1,698	548		
Lower	118,004	137,631			4,918	1,629		
Upper	141,049	161,884			8,313	2,725		
Chinook								
Escapement	48,936	43,694	-5,241	-10.7%	54,976	18,472	-36,504	-66.4%
Total Var	24,493,983	27,944,545			4,738,274	218,670		
SE	4,949	5,286			2,177	468		
CV	0.1011	0.1210			0.0396	0.0253		
90% CI	8,117	8,669			3,570	767		
Lower	40,819	35,025			51,406	17,705		
Upper	57,052	52,364			58,546	19,239		
Chum								
Escapement	80,480	85,643	5,163	6.4%	17,804	4,810	-12,994	-73.0%
Total Var	37,685,801	43,044,896			2,594,342	184,229		
SE	6,139	6,561			1,611	429		
CV	0.0763	0.0766			0.0905	0.0892		
90% CI	10,068	10,760			2,642	704		
Lower	70,412	74,883			15,162	4,106		
Upper	90,548	96,403			20,445	5,513		

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Coho	DIDSON NS	Bendix NS	Difference	Percent Deviation	DIDSON OS	Bendix OS	Difference	Percent Deviation
Escapement	6,550	6,452	-98	-1.5%	2,416	493	-1,923	-79.6%
Total Var	5,440,990	4,433,657			371,567	14,744		
SE	2,333	2,106			610	121		
CV	0.3561	0.3263			0.2524	0.2464		
90% CI	3,825	3,453			1,000	199		
Lower	2,725	2,999			1,416	294		
Upper	10,375	9,905			3,415	692		
Pink								
Escapement	116,367	96,710	-19,657	-16.9%	11,817	1,667	-10,150	-85.9%
Total Var	15,532,202	12,725,980			1,227,673	28,880		
SE	3,941	3,567			1,108	170		
CV	0.0339	0.0369			0.0938	0.1020		
90% CI	6,463	5,850			1,817	279		
Lower	109,904	90,860			10,000	1,388		
Upper	122,830	102,560			13,634	1,945		

APPENDIX D

MEMORANDUM

STATE OF ALASKA

Department of Fish and Game

To: Distribution **Date:** September 25, 2001

From: Nancy Gove **Subject:** Portage Creek
 Biometrician
 Species Allocation
 CFD, Anchorage

Introduction

This memo investigates alternative approaches for species apportionment for the Nushagak River sonar project. Alternative methods of apportioning the data are under consideration because of concerns about biased estimates and difficulties caused by retroactively changing abundance estimates.

The sonar counts are apportioned for each of the four strata in the river (inshore right bank, offshore right bank, inshore left bank, and offshore left bank). The current method divides the season into periods within each strata. To minimize the variance, the desired sample size for apportionment is 100 fish. A single period continues until 100 fish have been caught in the test fishery. A new period starts on the day after the 100th fish is caught. In almost all cases, the periods contained testfish data from multiple days.

Because the sonar data were apportioned over a number of days, there has been concern that the estimates of the proportions of species are not sensitive to changes in species composition, resulting in biased estimates. Also, managers desire escapement estimates on a daily basis during the season. With the current method, managers would use estimates of species abundance based only on the data collected to date; the managers would then have to change the estimates retroactively once the data for the entire period has been collected. Because the estimates were made public as the data was collected, changing the estimates causes confusion with the public.

The alternative approaches use a minimum sample size of 5 for apportionment. Using a smaller sample size for apportionment will increase the variance of the estimate, but any bias should decrease and any problems with retroactively changing estimates should be minimized.

The first approach will use periods as the current method does, but will have a minimum sample size of 5 fish per period instead of 100 fish from the testfish data. The second approach, will pool the testfish data by looking at window of the previous days' data until the pooled data contains a minimum of 5 fish. One should note that the retroactive pooling can only begin once five fish have been caught.

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Methods

Simulations were used to approximate the effects of the different approaches for apportioning the sonar counts on the bias and variance of the estimates. The simulations were based on the 2000 sonar and testfish data. The sonar counts per day for each strata and the total catch per session for each strata were fixed. Total catch per session was interpolated on days where beach seines were used for testfish data instead of gillnets. For the proportions of the different species in the simulations, the proportions in the 2000 testfish data were smoothed. The number of each species in the testfish catch for each session was randomly generated using a multinomial distribution with the sample size equal to the daily catch per session and the species proportions equal to the smoothed proportions from the 2000 data. The daily sonar and testfish catch were used so that the changes in species proportions, sonar counts, and testfish counts would be incorporated in the simulations.

After randomly generating data, daily counts of Chinook, sockeye, chum, pink, and coho salmon and other fish were estimated. One hundred iterations were used for the simulations. This number was sufficient to determine the general effect of using the different approaches. However, if one wants more precision, more simulations should be used. After the data were simulated, each of the approaches was used to apportion the sonar data on a daily basis.

Results

The simulations show that the methods using a minimum of 5 fish for apportioning the sonar data are less biased, but have more variation (Figures 1-6). The current method, which has a minimum of 100 fish per period, is biased because it uses multiple days to apportion the sonar data and is not sensitive to changes in species composition. In particular, the 100 fish method is positively biased around day 50 where the species composition shifts from Chinook, sockeye, and chum salmon to coho and pink salmon.

The performance of the different methods in estimating total abundance, depends on the species (Table 1). For Chinook, sockeye, and coho, the approaches with a minimum of 5 fish had less bias. For pink salmon, the current method had less bias. For chum salmon and other fish, all of the approaches performed well. Closer examination of the daily estimates, reveals that for both chum and pink salmon that current method performed adequately because positive and negative biases throughout the course of the run canceled each other when totaled.

The differences between the two approaches with a minimum of 5 fish were minimal.

Discussion

These simulations show that reducing the number of fish required to apportion the data will increase accuracy, but decrease precision. The current method using 100 fish per period is biased because it uses data from multiple days to apportion the sonar counts. Thus, the current method is not sensitive to changes in species composition, and will take time before the presence or absence of a species is detected. The bias of the old method supports the switch to one of the new methods.

The disadvantage of the new approaches is that they are less precise. If more precision is desired, one may want to increase the number of fish required to apportion to 10 or 20.

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However, the lower precision is not as bad as it initially appears. When the sonar counts are high, more fish are likely to be caught in the test fishery, resulting in more precision for large fish days.

The difference between using distinct periods for apportionment vs. pooling retrospectively is minimal. Managers may pool retrospectively when apportioning the sonar counts to avoid having to change their estimates in-season.

Table 1: Total escapement for each species estimated using the three approaches compared to the true abundance of the simulations.

	Chinook	Sockeye	Chum	Pink	Coho	Other
True Abundance	73,382	402,515	132,803	124,131	174,868	2,252
100 Fish Period	68,601	417,436	132,032	124,239	165,341	2,302
5 Fish Period	72,407	402,377	131,819	120,032	180,572	2,416
5 Fish Window	74,245	402,298	132,703	119,794	178,512	2,399

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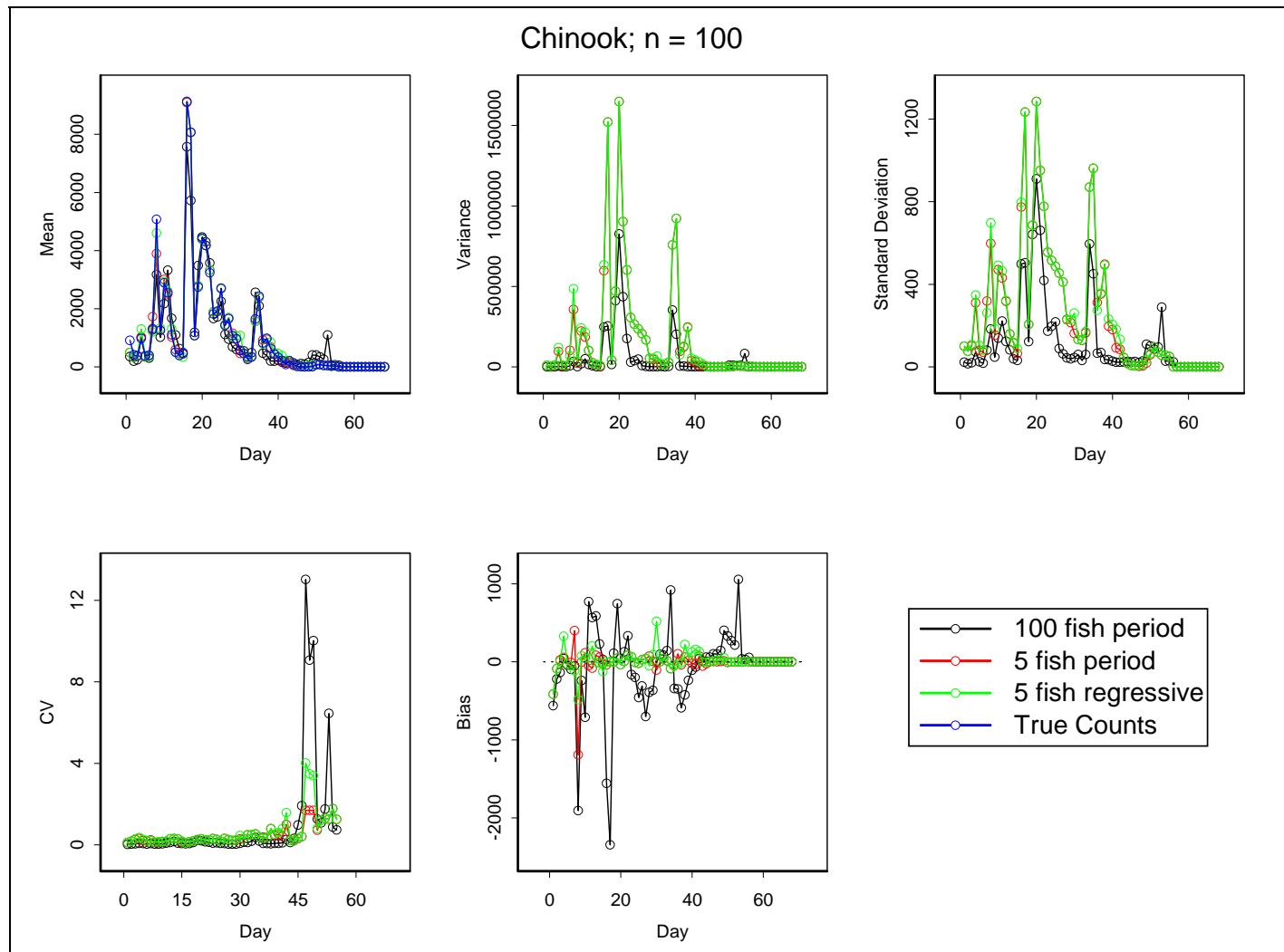


Figure 1: Simulation results of Chinook salmon. The mean, variance, standard deviation, CV, and bias are based on the estimated daily escapement from the simulations using the three different approaches. One hundred iterations were used in the simulations.

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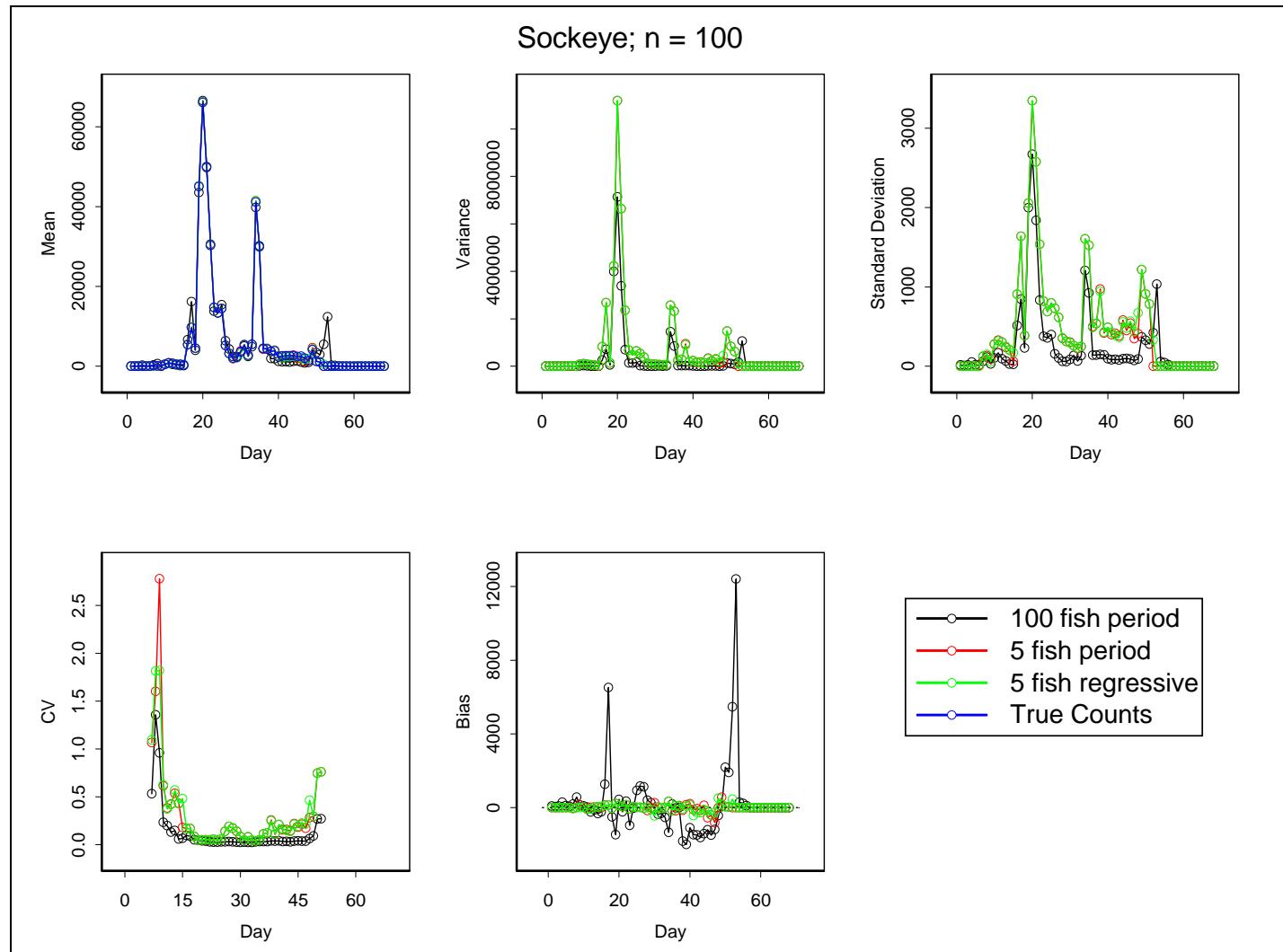


Figure 2: Simulation results of sockeye salmon. The mean, variance, standard deviation, CV, and bias are based on the estimated daily escapement from the simulations using the three different approaches. One hundred iterations were used in the simulations.

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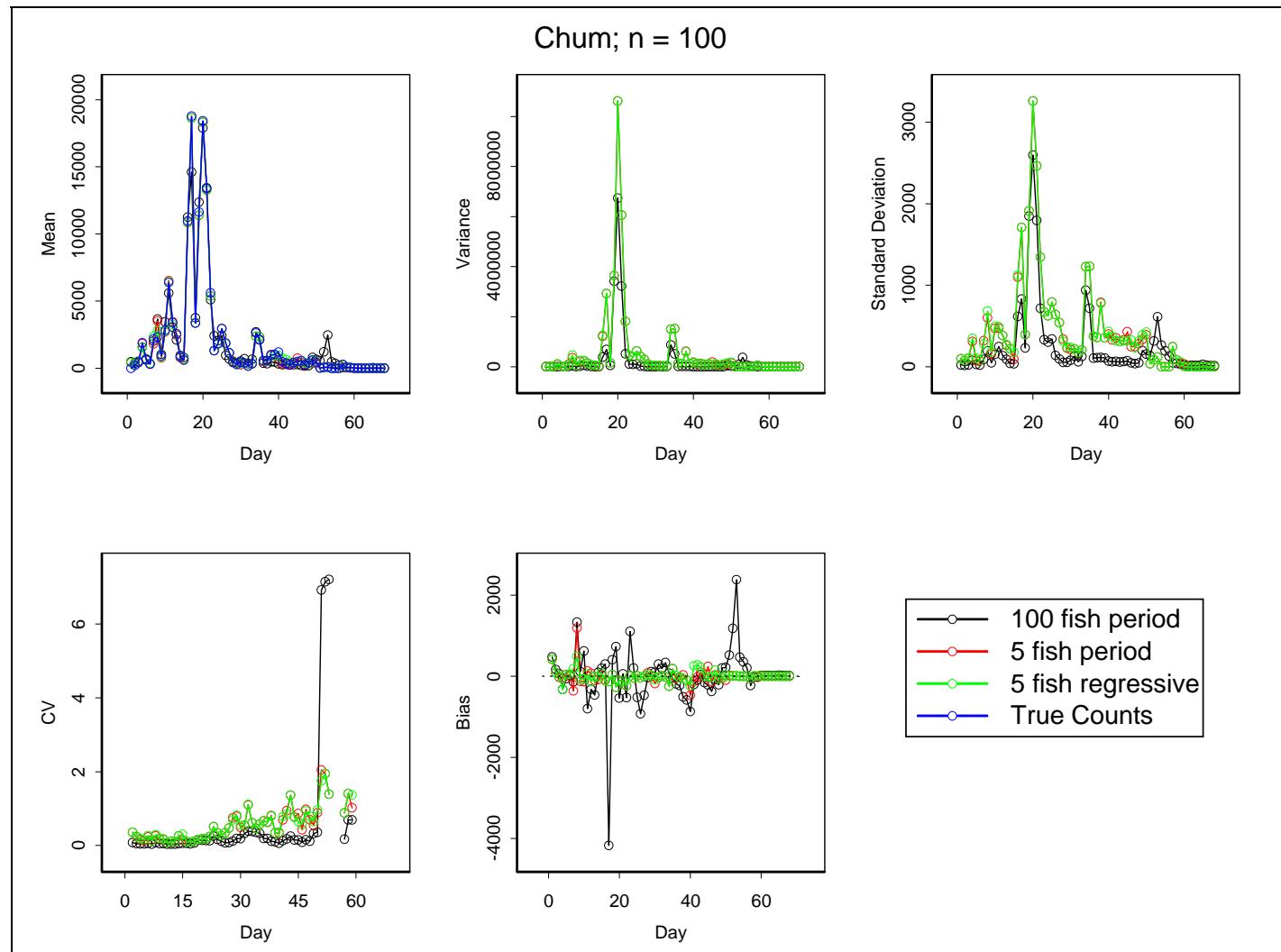


Figure 3: Simulation results of chum salmon. The mean, variance, standard deviation, CV, and bias are based on the estimated daily escapement from the simulations using the three different approaches. One hundred iterations were used in the simulations.

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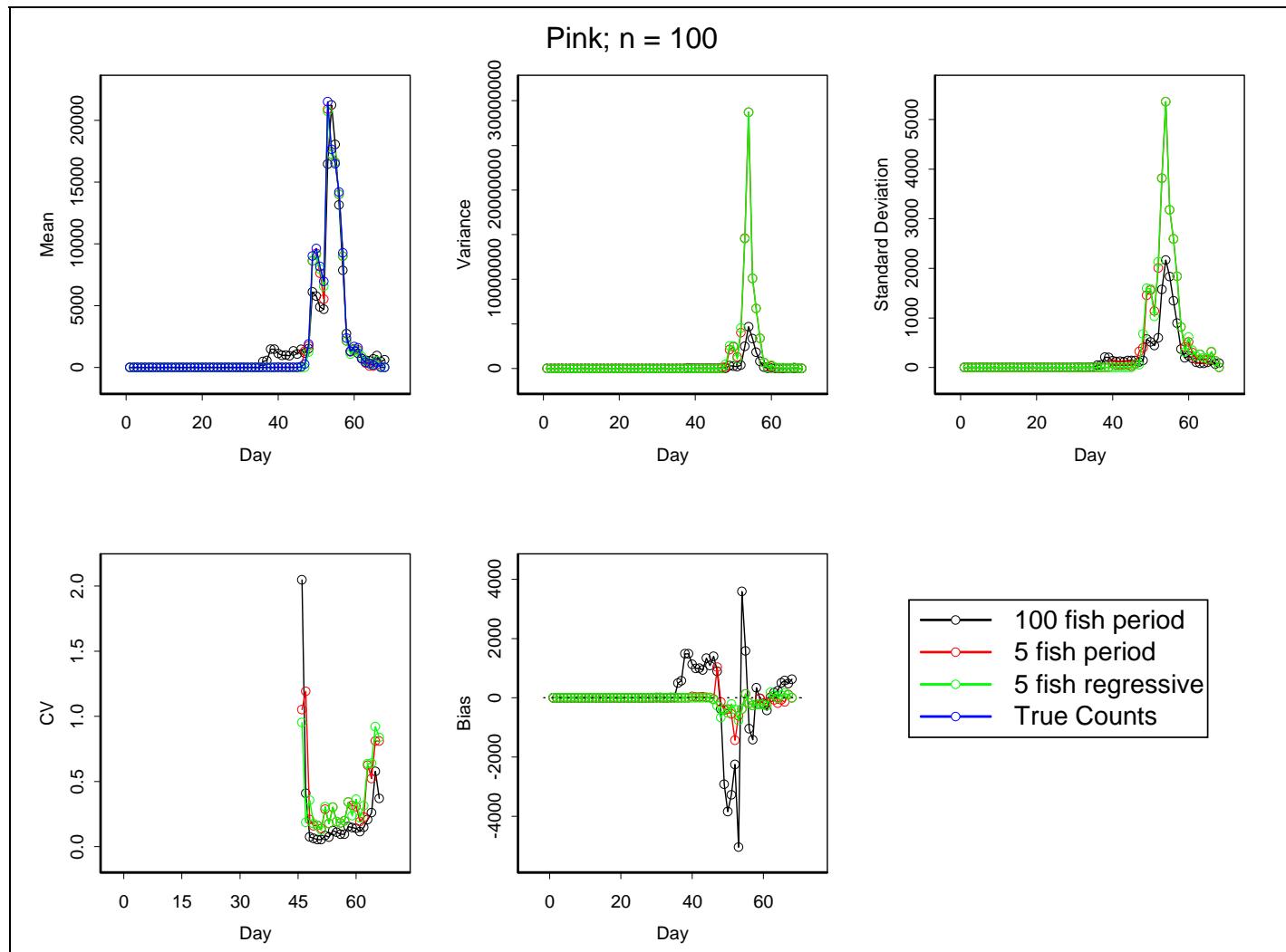


Figure 4: Simulation results of pink salmon. The mean, variance, standard deviation, CV, and bias are based on the estimated daily escapement from the simulations using the three different approaches. One hundred iterations were used in the simulations.

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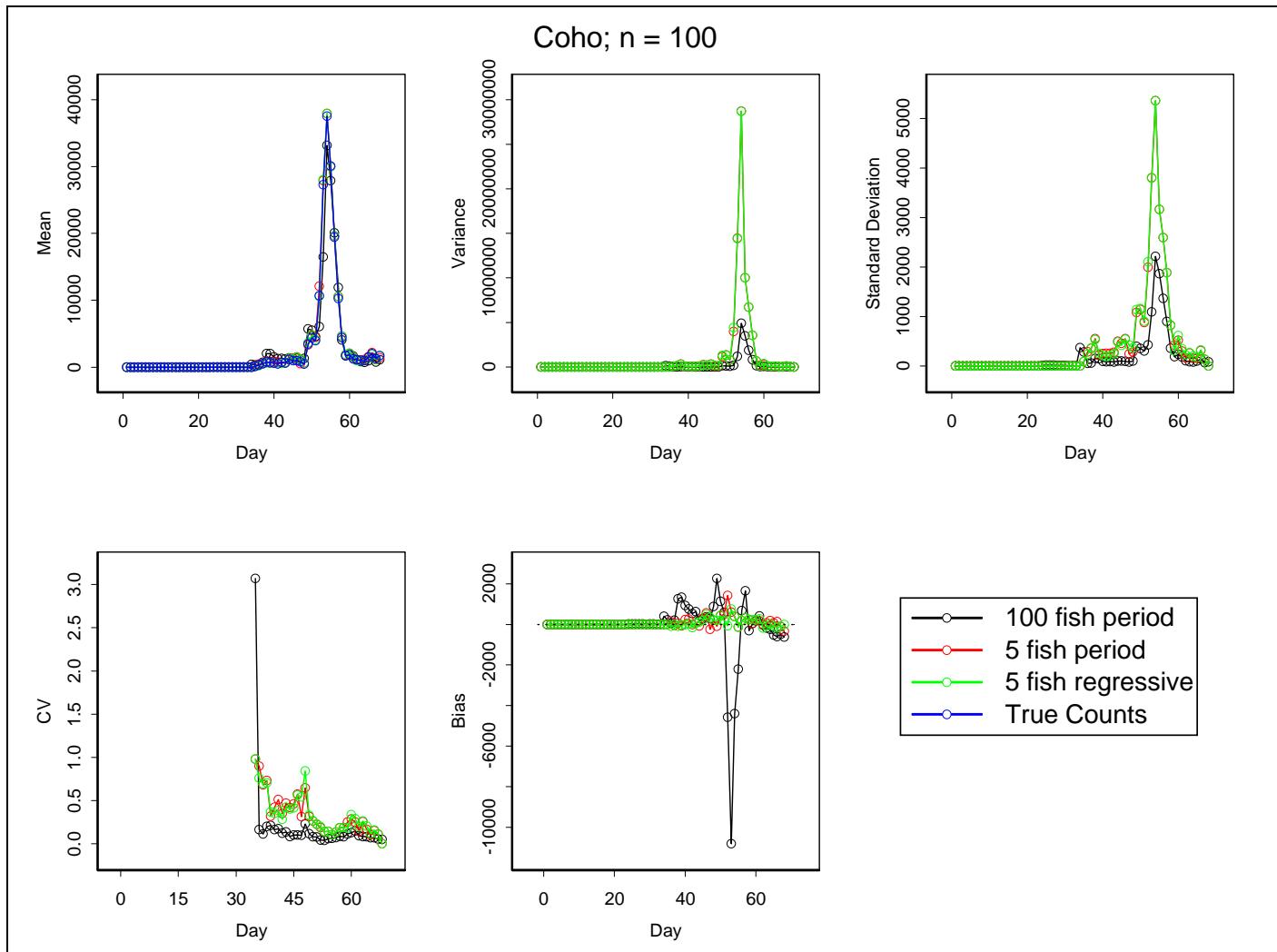


Figure 5: Simulation results of coho salmon. The mean, variance, standard deviation, CV, and bias are based on the estimated daily escapement from the simulations using the three different approaches. One hundred iterations were used in the simulations.

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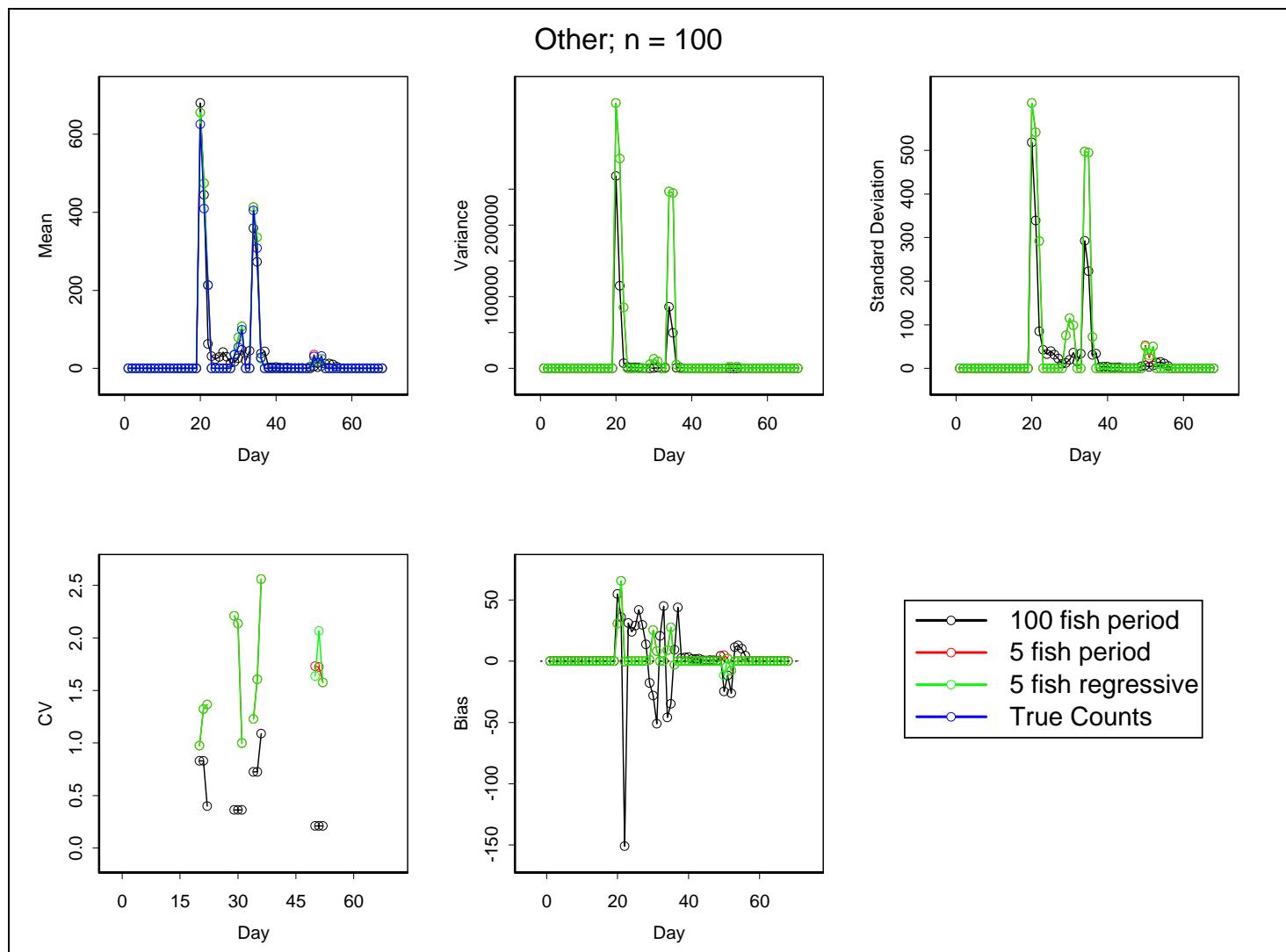


Figure 6: Simulation results of other fish. The mean, variance, standard deviation, CV, and bias are based on the estimated daily escapement from the simulations using the three different approaches. One hundred iterations were used in the simulations.